2016 SCIENCE REPORT

The Nature Conservancy in Illinois

The Nature Conservancy

Protecting nature. Preserving life.

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Compiled and edited by Sarah Hagen, Allison Cisneros, Krista Kirkham, Sally McClure, and Jeff Walk; May 2017

Front Cover: The Emiquon Water Control Structure separates the Illinois River and the Emiquon Preserve. Photo credit: Doug Blodgett/The Nature Conservancy.

The goal of this report is to summarize and catalog the diverse array of research being conducted on The Nature Conservancy's project areas in Illinois that occurred during 2016. Special thanks go to the researchers who are listed throughout the document and provided information on their projects. Thanks also to the staff of The Nature Conservancy in Illinois who contributed information for this report.

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We also thank the members of the Science Advisory Committee of The Nature Conservancy in Illinois's Board of Trustees. Their insight, experience, and guidance have greatly improved the strength of our work.

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2016 FEATURE

SCIENTIFIC RESEARCH AT EMIQUON'S AHSAPA

This year marked the completion of the one-of-a-kind water control structure at one of the largest floodplain wetland restorations in the Midwest—The Nature Conservancy's Emiquon Preserve along the Illinois River in west-central Illinois. The structure has been named "Ahsapa" which means "web" in the language of the Native Americans who once lived in the area; it symbolizes the importance of connectivity among nature's habitats (for example the river and its floodplain) and with people. While the primary purpose of the water control structure is management of water flows and levels, an important secondary objective of the design was for the structure to facilitate science and learning. The preliminary design for the structure was completed by the US Army Corps of Engineers in 2013. Subsequently, engineers from two local firms (Maurer-Stutz and Hanson Professional Services) worked with a team of Conservancy staff, trustees, and partners to redesign plans for the structure both to increase its flexibility for managing water and to expand its utility as a stage for scientific research and monitoring.

The initial plan for the water control structure identified a single large concrete culvert running 130 feet through the levee to allow the gravity flow of water between Emiquon and the Illinois River; after the redesign, that single culvert was replaced by two smaller culverts in the final plan. In addition to providing more flexibility for moving water, having the two identical culverts would aid in the experimental design for many scientific research projects. For example, researchers could apply a treatment to water flowing through one culvert, maybe a chemical to discourage unwanted fish from entering Emiquon, while adding nothing to the second culvert that becomes a control. Any differences in species, sizes and numbers of fishes moving through the treatment culvert compared with the control culvert could be attributed to the treatment. Having two identical culverts also provides opportunities to collect two duplicate samples or "replicates" at the same time to better understand sampling variability.

To accommodate the wide variety of scientific research and monitoring anticipated at the structure, sampling bays with sampling platforms were planned for both the preserve and river sides of the structure's culverts—each culvert with a bay and platform on each side, so a total of four sampling bays and platforms. The platforms were designed to provide researchers with a stable and safe working surface just above to the water that would be flowing through the culverts. The top of the sampling platforms were designed with removable metal gratings to provide easy access to the flow in the culverts. The sidewalls of the sampling platforms were to have six-inch-wide grooves or slots extending down vertically to the bottom of the structure. These slots are for deployment of sampling frames that could house a variety of experimental gears including underwater speakers (for putting sound into the water), gas diffusers, collection nets (for fish, invertebrates, and vegetation), flow meters, water sample collectors, and other such equipment. The slots would also be used to deploy management gear such as stop logs to control water levels and screens that could help restrict fish movements.

Looking from the Illinois River toward the gate structure in the Emiquon levee. The yellow crane on top of the structure is used to lift nets, other sampling devices, screens, and metal stop "logs" in and out of the gates. Stop logs are in place in the gate on the right, and screen is in place in the left gate, which is discharging water from Emiquon into the Illinois River. On top of the structure are two frames with underwater speakers that are used to test the effectiveness of sound in repelling Asian carps. The structure on top of the levee behind the white van houses data loggers. A mast with meteorological sensors is to the right of the instrument house. Photo by R. Sparks 8 August 2016.

In part because of a dam on the Illinois River forty miles below Emiquon that pools water deep enough to allow 9-foot-draft barges to navigate, the river does not drop as low as it did naturally. As a result, extremely important low water periods cannot be reestablished at Emiquon by gravity flow to the river. The new structure was designed with auxiliary pumps that could lower water levels below the level of the unnaturally high river. Discharge of those pumps was to be routed into the two river-side sampling platforms on the structure to allow analysis of the pumped water similarly to the water moving by gravity flow.

After over a decade of planning, a contract was signed and construction began in late April of 2015. The initial phase of construction was focused on site preparation and included removing the 1940s-era pump house and five large pipes that formerly discharged water from the agricultural lands through the 20-foot levee to the Illinois River. Soon after those structures were

removed, we experienced the second highest flood on record for the adjacent Illinois River. As the river rose within a few feet of the top of the levee, the water's hydraulic pressure forced water through the levee in places at the construction site. Such upwellings or "boils" are not uncommon during extreme floods, but as a result, the levee became unsafe and construction came to a standstill. Some measures were implemented to moderate those flows through the levee in hopes of preventing a levee failure. During frequent and observations of the site during the flood, we witnessed a variety of fish-eating birds wading in the flow coming through the levee. On closer inspection, we saw they were feeding on small fish coming through the levee with the flow. In addition to these relatively small native fish, extremely small larvae of Asian carp were observed.

While the river crested on the 1st of July, the flood receded slowly and the contractor wasn't able to resume activities until late August. Delays associated with procuring equipment and supplies and then the fourth highest Illinois River flood on record in January 2016 further delayed construction. Finally, in July of 2016, the structure was partially functional and water flowed from Emiquon's wetland into the Illinois River for the first time in nearly a century. With the sampling bays and platforms completed as designed, scientists initiated monitoring and research projects right away to help us better understand and manage the important and dynamic relationships between the river and its floodplain. For example, as water flowed through the culverts from Emiquon to the Illinois River, we deployed nets into the slots of the sampling platforms on the Emiquon side to collect fish moving with the flow from the wetland to the river. Different nets were deployed on the river side to sample fish attempting to move against the current and into Emiquon from the river. Over time, this monitoring will allow us to better understand and potentially manage relationships among the movements of different species and life stages of fishes and environmental conditions such as water levels, temperature, season, and time of day. Preliminary research in 2016 identified eleven species of fish attempting to immigrate into Emiquon from the river and six species emigrating from Emiquon into the river. At one time, nearly 500 fish per minute were being stocked into the river from Emiquon, reestablishing this floodplain wetland as an important contributor to the fish community in the Illinois River. Two native fish species, white bass (*Morone chrysops*) and highfin carpsucker (*Carpiodes velifer*), collected trying to emigrate to the river were not stocked and had not been previously documented in Emiquon; these species likely came in when floodwaters overtopped the levee during floods in 2013, 2015 or 2016, although other dispersal mechanisms are possible.

The structure is also contributing to research investigating strategies to control movements of invasive species such as Asian carps. Over the past few years, laboratory experiments have shown carbon dioxide and complex sound as promising deterrents for controlling movements of some fishes. However, a multitude of challenges associated with conducting experiments in the open river had limited progress in developing those control strategies. The dual-culvert design and the sampling platforms at our Emiquon structure provided an effective stage for further evaluating these control strategies in the field. Based on results from preliminary experiments conducted in the fall of 2016, additional and more extensive trials are being planned for 2017. Partners in research at the structure include personnel from three US Geological Survey laboratories (La Crosse WI, Columbia MO, and Urbana IL), the University of Minnesota Duluth,

and two Illinois Natural History Survey facilities (Forbes and Illinois River Biological Stations); summaries of their findings are provided elsewhere in this document. In addition to applications at managed floodplain reconnection projects such as Emiquon, Chautauqua National Wildlife Refuge and Spunky Bottoms, information gained at the structure will have applicability for efforts to control invasive species movements among drainage basins – for example, between the Mississippi and Great Lakes basins through the Chicago Area Waterways.

The recent acquisition of sophisticated flow meters for the two culverts will allow us to document the velocity and volume of water flowing through the structure. Velocities are important in understanding fish movements as higher velocities increasingly restrict movements of fishes, especially smaller ones, against the current. Additionally, high velocities can sweep fish, especially smaller ones, with the flow. Combined with concentration estimates for a broad variety of materials carried by the flowing water such as sediment, nutrients, zooplankton and phytoplankton, and plant seeds and other propagules, accurate volume estimates will allow us to calculate loads transported to and from the river.

Science tells us that hydrology is key to restoring and sustaining high-quality wetlands, and since the Conservancy's initial workshop with the Emiquon Science Advisory Council in 2001, the importance of a water control structure for managing Emiquon long term has been investigated, debated, and planned. With the water control structure's completion in 2016, we are on the cusp of the many contributions it will make to our understanding and management of the dynamic relationships between large-floodplain rivers and their floodplains and the phenomenal diversity and abundance they support.

Doug Blodgett, Director of River Conservation, The Nature Conservancy

2016 Research at Project Sites

ILLINOIS RIVER: EMIQUON & MERWIN PRESERVE AT SPUNKY BOTTOMS

The Illinois River Program presents a synopsis of the research projects that take place at The Emiquon Preserve and the Merwin Preserve at Spunky Bottoms. In 2016, nearly 30 diverse research projects took place on our preserves ranging from fish and waterfowl research to human aspects. 20 publications and over 30 posters or presentations were in part a result of the research at Emiquon and Spunky. A variety of entities participated in these research projects including TNC, universities, field stations, the State of Illinois, and the Federal Government.

Fish Sampling at Emiquon's Ahsapa

Initial fish collections in the water control structure have been to (1) develop effective sampling methodologies, (2) investigate fish emigration and immigration between Emiquon and the Illinois River, and (3) initiate testing for two potential control technologies (complex sound and carbon dioxide). From 8 July through 17 November 2016, a total of nineteen fish collections were completed using nets in the water control structure while water was flowing through it from Emiquon into the river. Nets used were modified Long Term Resource Monitoring fyke/trap nets. Nine collections were for fish emigrating from Emiquon into the Illinois River and ten were for fish trying to immigrate into Emiquon from the river. A total of thirteen fish species was collected-- six species emigrating from Emiquon and eleven species immigrating in. In all, an estimated 17,721 individual fish were collected, 17,489 from emigration collections and 232 from immigration. Numerically, young-of-year gizzard shad (*Dorosoma cepedianum*) dominated in both emigration and immigration collections at 85% and 71% respectively of total fish collected. Catch rates varied from 0 fish/minute for one immigration collection to a maximum of 485 fish/minute for one emigration collection. Additional collections are being planned for 2017.

Doug Blodgett, The Nature Conservancy

Weather Monitoring at the Emiquon Preserve

Starting in 2003, precipitation gauges at Emiquon are manually read after precipitation events, currently, five rain gauges that are spread out on the preserve are being manually read. An automated meteorological station was set up at the control structure building. Weather parameters measured every five minutes include wind speed and direction, temperature, humidity, barometric pressure, and rainfall. Data are automatically collected and sent to a data logger.

Sally McClure, The Nature Conservancy

Illinois Rivers Program's New Headquarters

In 2016, The Nature Conservancy received funding from Tellabs Foundation and began work with Farnsworth Group and Morton Buildings to design and construct a LEED-certified office with attached maintenance shop. Much effort has been made to design and construct the most efficient and economical building practical. LEED (Leaders in Energy and Environmental Design), Net Zero and PHIUS+ (Passive House Institute in the U.S.) certifications have been evaluated by our consultants and staff to determine best fit for this project.

LEED is a rating system with specific objectives (or "points") that a team pursues to achieve certification at one of four levels (certified, silver, gold, platinum). With the LEED rating system, the focus is on achieving these points in five key areas: sustainable sites, materials and resources, energy and atmosphere, water, and indoor environmental quality. To achieve LEED certification, there are significant additional tasks with associated costs, to verify that these points are achieved. The added costs include creating an energy model, completing extensive paperwork, and the additional costs of building materials needed to achieve the LEED rating. The LEED rating system requires submitting paperwork for certification twice during the project: at the end of design and at the end of construction phases. Therefore, the project achieves LEED certification prior to seeing how the building performs. Energy efficiency is only one piece, albeit significant, of the LEED rating system, with sustainable sites, water efficiency, indoor environmental quality, etc. being the other areas.

Net Zero is not a rating system, but rather a concept that the building will produce the same or more energy than it uses. If it produces more energy, sometimes the term "restorative building" is applied because the building will have a "net positive" effect on energy use and the Earth.

PHIUS+ (Passive House Institute of the United States) certification. PHIUS+ is another rating system, similar to LEED, in which specific requirements must be achieved focusing on energy performance, durability, and the thermal envelope in a much more focused way than LEED. PHIUS+ dictates certain testing and observation of actual energy use to ensure that the building performs during the initial 12 months of occupancy.

After careful consideration including overall construction costs, the decision is to pursue LEED certification and attempt to obtain functional Net Zero. Currently the design meets the certified level of LEED, but it appears likely that as we continue to develop the final plans, we will achieve silver or even gold level certification.

Jason Beverlin, The Nature Conservancy

Update on Emiquon Key Ecological Attributes

The Nature Conservancy acquired the Emiquon Preserve along the Illinois River, Illinois, with the primary objective of restoring ecological floodplain processes and habitats that promote and sustain native species and communities. The Conservancy convened an Emiquon Science Advisory Council prior to restoration implementation that identified Key Ecological Attributes (KEAs) for riverine and backwater targets, KEA indicators, and acceptable ranges for those indicators. In a paper recently

submitted for publication, we assessed the application of this methodology to evaluate status of conservation targets and to inform future science and management at Emiquon.

Application of the KEA framework provided strategic and systematic monitoring data that resulted in consistent and timely assessments of trending patterns for focal conservation targets at the Emiquon Preserve. Data from the 68%-75% of indicators that were monitored during the first eight years of restoration showed that 46%-55% of all indicators were within acceptable ranges. These results are not surprising given the short time since restoration began and the lack of water management capacity during this time. A large proportion of the indicators that were not monitored are dependent on water level management and are not expected to change until the Conservancy begins to manage hydrology; such indicators include seasonal waterbird feeding habitats (e.g., mudflats), bottomland forest recruitment and *B. decurrens* establishment. Several other indicators are long-term measures related to bottomland forest restoration that will take years to decades to mature and reach the defined acceptable ranges.

Conservation efforts to date are just the initial steps towards restoration of ecological integrity at the site with the next step being utilization of a managed connection between the Preserve and the Illinois River. Completion of a water control structure in 2016 represents a critical intervention that provides potential to improve conservation status of those floodplain and riverine targets that depend on water management and river connectivity. Our ability to manipulate water levels will provide new management options for controlling invasive species, maintaining hemi-marsh conditions, improving waterfowl and shorebird nesting and feeding habitats, and creating passage for riverine fishes to high quality backwater habitat. As such, water management capacity is expected to increase overall ecological integrity of the Emiquon Preserve by providing the system with the ability to support and maintain biodiversity, aquatic plant communities, and ecosystem function. Continued review and modification of the KEA model in conjunction with a strategic monitoring program will provide fundamental data to guide relevant management decisions and to develop testable hypotheses to reduce potential threats and achieve future restoration goals. This will inform management of future floodplain restoration and reconnection projects, thus, meeting the overarching goal established during the early planning process to provide a foundation for future restoration investments in the larger Illinois and Upper Mississippi River valleys.

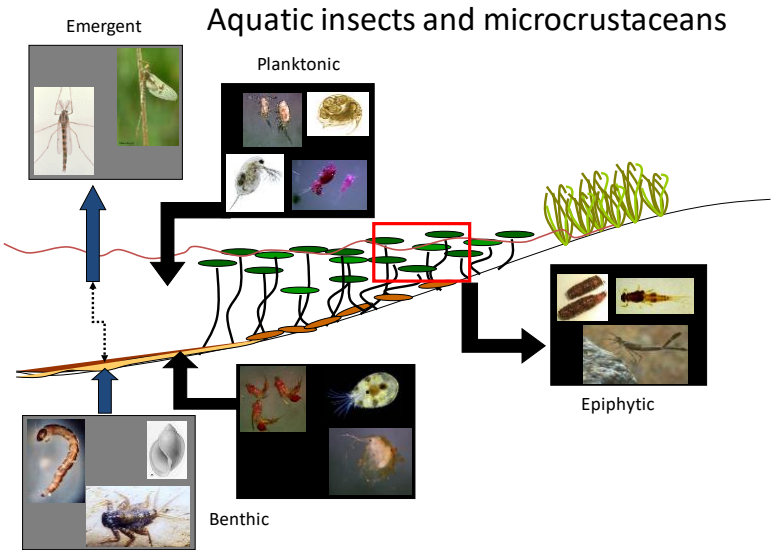
Maria Lemke, The Nature Conservancy

Invertebrate Communities at the Emiquon Preserve

Invertebrates play an important role in freshwater systems, both as consumers of algae and as valuable food resources for fish, waterfowl, and other organisms. Over the years, we have collected invertebrates from multiple habitat types at Emiquon to quantify the benthic macroinvertebrates and microcrustaceans that inhabit the sediments, emergent adult insects, and planktonic invertebrates (i.e., zooplankton), from the water column. Zooplankton are animals that drift in the currents of oceans, seas, and freshwater systems. They are usually microscopic, although some can be seen with the naked eye.

Benthic macroinvertebrates that we collected mainly consisted of larval insects (e.g., dragonflies, beetles), but we also collected some other cool creatures like fingernail clams and planarians (free-living flatworms).

We began sampling invertebrates from the drainage ditches at Emiquon in 2003 when the site was still in agriculture. As restoration of Emiquon began and the pumps were turned off in 2007, we began to sample transects that included vegetation sites, open water sites, and shallower nearshore sites to represent the diversity of habitats that now exist. We predicted that as the site transitioned from ditches to a more complex system that we would see increased diversity, community shifts in terms of numbers of species and relative abundances, increased biomass and secondary production.

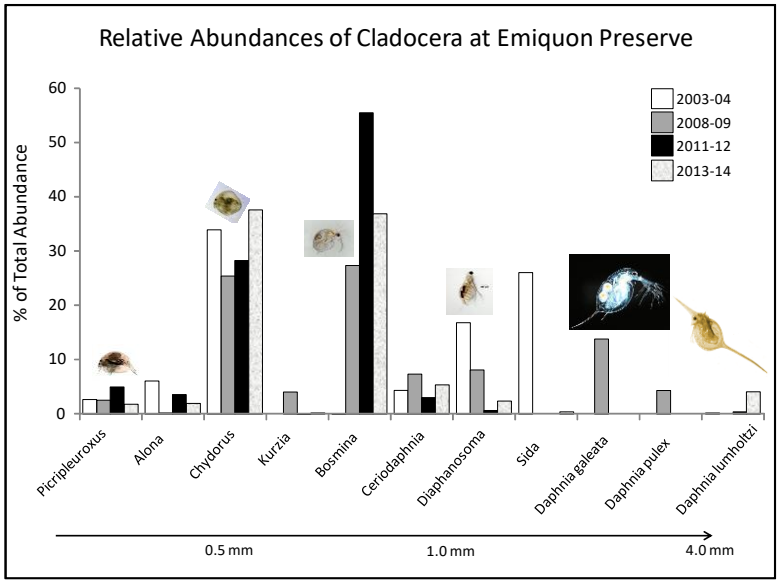


Zooplankton Community Measures

	2003-04	Pumps turned off ↓ 2008-09	2011-12	Levees overtopped ↓ 2013-14
Richness (# sp)	90	72	88	96
Rotifera	70 (78%)	54 (75%)	67 (76%)	61 (70%)
Diversity (H')	0.97	0.97	0.96	1.23
H_{max}'	1.95	1.86	1.94	1.98
Evenness (J')	0.50	0.52	0.49	0.62

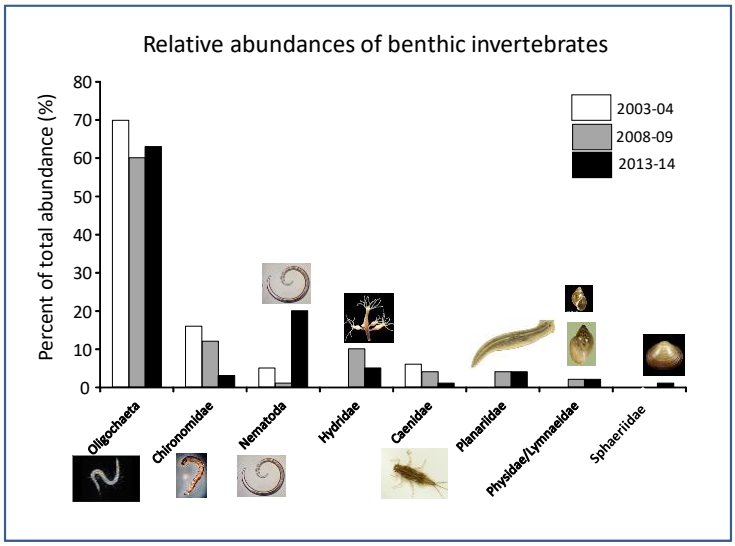
A quick look at zooplankton community measures show an initial drop in species richness after the pumps were turned off and recovery to pre-restoration levels in 2011-12. About 70 species of rotifers have been identified during any given year from Thompson Lake, and not surprisingly, they comprised 75-80% of total species numbers. Overall diversity measures remained pretty much the same throughout this period, and it wasn't until after the levees were temporarily overtopped in 2013 that we measured an increase in zooplankton species richness, diversity and evenness.

Zooplankton communities in the agricultural ditches were generally dominated by small species of chydorids and the sidids, *Diaphanosoma* and *Sida*. There was a big shift in community composition in 2008 with the addition of new species, including several very large *Daphnia* species. Community composition shifted again in 2011 as these larger-bodied species disappeared and the community was once again dominated by smaller species. After the 2013 flood, we observed higher numbers of the exotic species, *Daphnia lumholtzi*, in Thompson Lake.



One explanation for the shift in species composition can be traced to the fish stocking that was conducted around 2008. At this time Emiquon was stocked with about 32 species of native fish. At the same time that fish were stocked, the water clarity was very high, which would have increased susceptibility of large zooplankton species to predation - so kind of a double whammy.

Preliminary data for the benthic macroinvertebrates also show a shift in community structure from one dominated by aquatic worms, chironomid larvae and *Caenis* mayflies to one that includes increased relative abundances of nematodes, hydra (freshwater relatives of jellyfish), snails and sphaeriid fingernail clams.



Maria Lemke, The Nature Conservancy

Water Level Monitoring at the Emiquon Preserve

Since 2003, TNC has been recording water level data using a manually read staff gage at one location on the Emiquon Preserve. In 2016, manually read staff gauges and automatic digital sensors were installed on both the Emiquon and Illinois River sides of Ahsapa (water control structure). Additionally, manually read staff gauges were installed on the Emiquon side of both culverts.

Mark Jones, The Nature Conservancy

Spring Breeding Bird Survey at the Emiquon Preserve

Bird populations at the Emiquon Preserve have been monitored during the breeding season since 2004. Birds are monitored using point counts, which are distributed throughout the property. Twelve points have been established throughout the preserves with the distribution intended to capture representative habitats found within the site. Four points are included in the three major habitat types. Habitats include upland tallgrass prairie, bottomland hardwood forest restoration, wet prairie or sedge meadow. For uniformity and comparison to other surveys, notations are made for three, five, and six-minute time intervals. Counts are taken at each census point location five times per year between 15 May and 15 June and all birds seen or heard at each point are recorded. This year two volunteers; Mathew Winks and Ted Hartzler conducted the surveys.

Tharran Hobson, The Nature Conservancy

Aerial Photography

Georeferenced, high-resolution (6 inches per pixel) natural color (red, green, blue) aerial imagery was collected in August 2016 for Spunky Bottoms and Emiquon Preserves by staff of the US Fish and Wildlife Service. Images were orthorectified and mosaiced by staff of the US Geological Survey's Upper Midwest Environmental Science Center. Processed imagery is being used as part of long-term monitoring to assess plant community changes and provide feedback for adaptive management at the sites as well as for other research projects.

Doug Blodgett, The Nature Conservancy

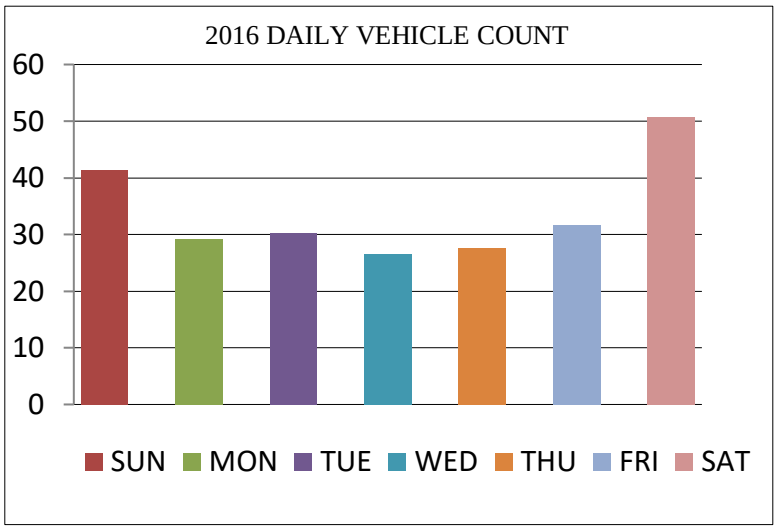
Yellow Spring Instruments water quality monitoring at Emiquon Preserve

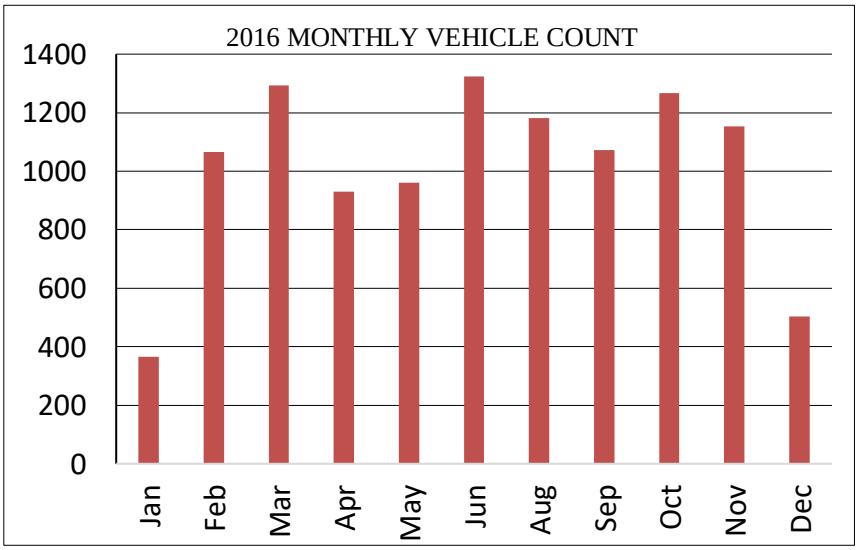
Water quality data are collected at Emiquon using monitoring equipment donated by Yellow Springs Instruments out of Yellow Springs, Ohio (YSI). Data collected include: dissolved oxygen, water temperature, turbidity, pH, conductivity, and water depth. Units are programmed to collect data every 15 minutes. A YSI sonde has been deployed in the main ditch near the pumping station at Emiquon since 2005.

Sally McClure, The Nature Conservancy

Traffic Counter

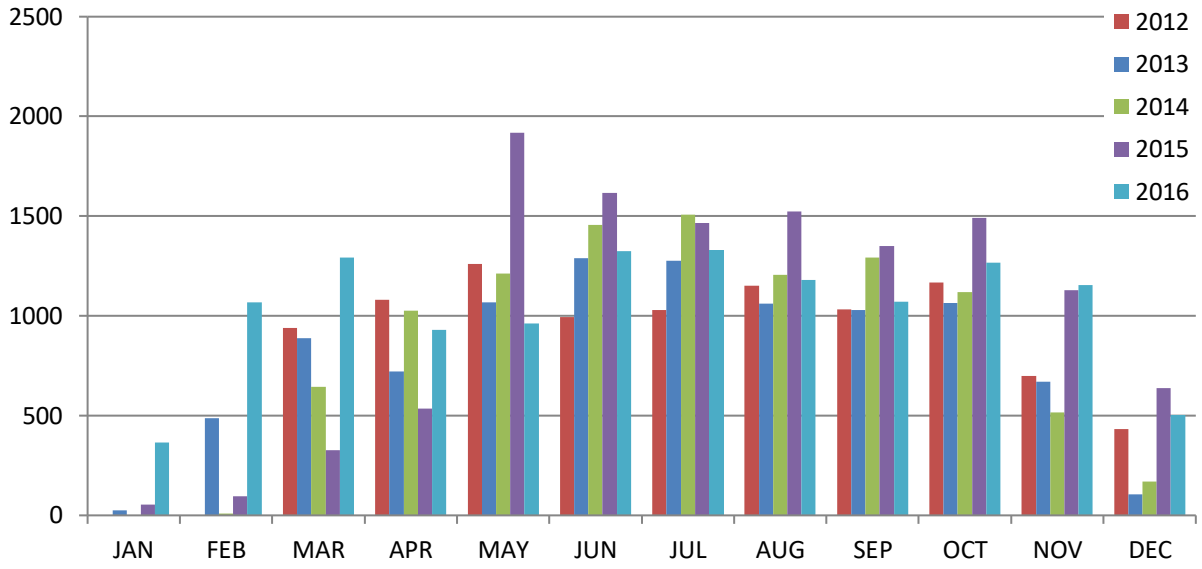
Due to lack of snow in December 2015 and January 2016, the Pico Vehicle Count Meter was left installed to count vehicle traffic at the Emiquon Preserve's Visitor Use Area every day in 2016. This data is from 1 January – 31 December, 2016. A total count of 12,429 cars drove over the counter in that period, which was only 40 fewer cars than in 2015. The Wetland Observatory was closed to the public on 5 and the Visitor Use Area Observatories were closed to the public on 1 April and reopened on 15 November. The average weekday count was 29 cars with Fridays being the busiest. The average Saturday/Sunday count was 92 with Saturdays seeing the most vehicles. The 2016 daily vehicle graph shows the daily vehicle count for each day Sunday through Saturday. The average weekly count was 239 vehicles and the busiest week was the week of 1 February with 403 vehicles with over 200 vehicles on 6 February for the Eagle Day festivities.





The counter encountered some problems and had to be sent in for repairs from 27 March – 6 June so traffic was not counted during this time. The count during this time is an estimate from the traffic during this time frame from the previous two years.
June was the busiest month with 1323 cars followed by March with 1292 cars. The Monthly Vehicle Count graph shows the monthly vehicle count. The monthly average was 1036 cars.

Since we have had the traffic counter out for five years I thought it would be interesting to compare the Visitor Use Area over the last five years. The graph below shows the data from 2012-2016.



Cammy Smith, The Nature Conservancy

<u>Emiquon Preserve Visitor Use Survey and Creel Survey Report 2016</u>

To assess public use of Emiquon Preserve's Visitor Use Area, demographic information, and general knowledge of the preserve, a survey has been given to Emiquon visitors in 2011 and repeated in 2016. In addition, a Creel Survey was conducted for anglers, which aimed to determine fish species targeted, length of trip, and fish species caught and kept. This report aims to evaluate the visitor use as well as the creel survey results of the Emiquon Preserve. Overall, 43 surveys were completed: 36 angler surveys and seven non-angler surveys, from 12 June to 27 July 2016.

Visitor Use Survey Results

Most visitors to the Emiquon Preserve were from Tazewell (27%) and Peoria County (25%). Both counties are approximately an hour drive from the Emiquon Preserve. Roughly a fourth (~24%) of the visitors to the Emiquon Preserve were from Mason and Fulton, the counties surrounding the Emiquon Preserve. Only one visitor was documented as coming from out of state: Cincinnati, Ohio.

Fishing attracted the most visitors to the Emiquon Preserve during the sampling period (36 out of the 43 surveys). The majority (70%) of visitors to the Emiquon Preserve, in total, spent $25 or less on food, gas, lodging or equipment for their trip. A little more than a third of visitors (40%) spent all their costs associated with their trip locally in Fulton or Mason County.

Overall, 68% of visitors knew that the Emiquon Preserve was privately owned. However, almost a fourth of the visitors (23%) thought it was State owned. In comparing perceived ownership between anglers and non-anglers, 69 % of anglers and 57% of non-anglers knew that the Emiquon Preserve was private. In regards to their familiarity with TNC, visitors responded almost equally between the answers "somewhat," "slightly" and "not at all."

46% of respondents relayed that they learned about the Emiquon Preserve from a friend or relative. Approximately one-fifth (21.7%) of visitors said they knew of the Emiquon Preserve because they were local. One visitor claimed that they heard about the Emiquon Preserve from Bass Pro Shop in East Peoria. The responses were split almost equally between 1 – 5 visits and >10 visits to the Emiquon Preserve in the past year. Only one group surveyed had never been to the Emiquon Preserve before, and 98% of visitors said that they plan on returning to the Emiquon Preserve later this year.

Creel Survey Results

The most frequently targeted fish species was crappie (*Pomoxis* spp.). Bluegill (*Lepomis macrochirus*) was the second most targeted species, followed by largemouth bass (*Micropterus salmoides*).

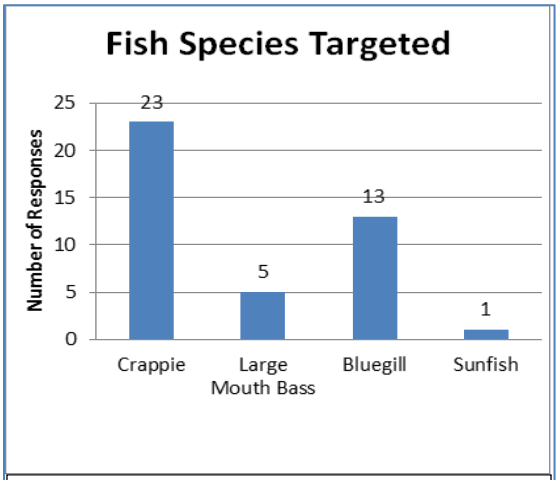


Figure 2. A graph illustrating the fish targeted.

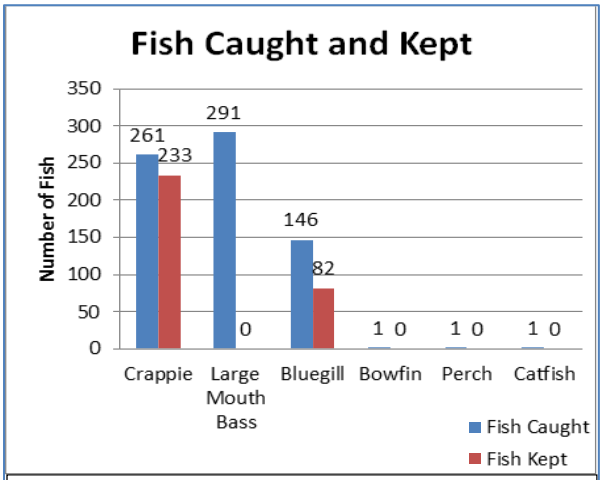


Figure 14. A graph illustrating fish kept.

At 291 catches, largemouth bass were the most caught fish at the Emiquon Preserve during the sampling period. None of these fish were reportedly kept. The second most popular catch was crappie, at 261 caught and 233 kept. Not far behind was bluegill, at 146 caught and 82 kept. The average amount of time spent on each fishing trip was 4.6 hours, with a minimum of 2.5 hours and a maximum of 7.5 hours.

Comments

The clear majority of visitors to the Emiquon Preserve had overwhelmingly positive comments about the success of the conservation project, the beauty of Thompson and Flag Lakes, and the great opportunities for birding and fishing. The bulk of the complaints centered on the lack of public restrooms and trash cans. Multiple visitors even offered to pay a small fee to fish to help TNC pay for these facilities.

TNC's goal to enhance and preserve a portion of the Illinois River basin has proven to be successful given these results. The Emiquon Preserve has and will continue to provide visitors with a better insight on the ecological, economical, and culturally historic value of floodplains in Illinois.

Megan Hoff, The Nature Conservancy
Molly Jugovic, Eureka College

Fish and Aquatic Vegetation Monitoring

The Illinois River Biological Station evaluated some of TNC's KEA's to determine restoration success in Thompson and Flag lakes. Standard fish monitoring of Thompson and Flag Lake occurred on nine different days between July and October 2016. A total of 2,049 fishes, with 19 species, representing eight families were collected. Sampling consisted of pulsed DC electrofishing, fyke, and mini-fyke netting. Three random sites are selected for each gear type during each month sampled and one fixed site for each gear for each month sampled. Some water control structure monitoring was done and a total of 657 fishes, with 28 species, representing ten families were collected. Aquatic vegetation monitoring consisted of twenty random box samples taken on 28 September, 2016.

Olivea Mendenhall, Illinois River Biological Station

Sportfish Dynamic Rate Functions

The objective of this project was to document and investigate the differences in the dynamic rate functions and occurrence of intersex of largemouth bass, bluegill, and black crappie (*Pomoxis nigromaculatus*) in the upper IL River, lower IL River, and Emiquon. In two days, 41 black crappie, 39 bluegill, and 40 largemouth bass, were collected from Emiquon. The records kept include: Species, Collection Date, Gear, Location, Reach, Total Length (mm), Weight (g), Sex, Gonad Weight (g), Gonad Storage, Liver Weight (g), Age, and presence of Roundworms (Y/N).

Rich Pendleton, Illinois River Biological Station

Population Demographics of Ancient Sport Fishes

Age and size data will be used to estimate various population demographics of gars (*Lepisosteus* spp.) and bowfin (*Amia calva*) in Emiquon. Gar and bowfin were collected using pulsed DC electrofishing and fyke nets. Fish were weighed, measured and the left most anterior pectoral fin ray was removed for age estimation (non-lethal process). Each individual was also floy tagged (tags contained individual identification number) at the base of the dorsal fin (non-lethal). A total of 26 individuals (twelve bowfin, six longnose gar (*L. osseus*), six shortnose gar (*L. platostomus*), and two spotted gar (*L. oculatus*)) were sampled from Emiquon. Fish were collected on seven sampling dates. All fish measurements will be added to the Illinois Natural History Survey's statewide ancient sport fish database. Pectoral fin rays will be processed and aged within the next year. All fish were immediately released after data collection. Water quality parameters were recorded at each site using a YSI and secchi disk.

Sarah King (Huck), Illinois Natural History Survey

Carbon Dioxide Fish Barrier

Carbon dioxide barriers are one of many approaches being considered to reduce the upstream movement of Asian carp. Promising results have been obtained in controlled laboratory and pond studies where Asian carp have shown strong avoidance and reduced upstream passage when exposed to elevated carbon dioxide concentrations. However, more research is needed to determine the efficacy and feasibility of this method for field applications.

In October 2016, we conducted a small field trial at the water control structure on the Emiquon Preserve. The structure served as a pinch-point for fish movement and water release. The objectives for our research were to (1) inject carbon dioxide to attain >100 mg/L CO2 and (2) determine the effectiveness of carbon dioxide to reduce the abundance and movement of fish near the water control structure. Carbon dioxide was injected using numerous air diffusers placed throughout the area near the structure. Fish abundance and movement was monitored using Adaptive Resolution Imaging Sonar (ARIS). Water quality was monitored throughout the structure, plunge pool, and Illinois River using stationary sondes, grab samples, and mobile transects. Results from this study are a step towards identifying the effectiveness, feasibility, benefits, and challenges associated with using carbon dioxide as a barrier to Asian carp.

Aaron Cupp, U.S. Geological Survey, Upper Midwest Environmental Sciences Center

IDNR Fisheries Management

A main goal of The Nature Conservancy's Emiquon Preserve is the restoration and conservation of natural ecological processes and habitats that sustain native plant and animal communities of the Illinois River. A secondary goal is to maintain a sport fishery for native fish of the Illinois River flood plain. According with the IDNR/TNC cooperative fish management plan, the district fisheries biologist, Rob Hilsabeck, collected, stocked, and conducted other fishery related work and management as necessary. The work was conducted as agreed in the fish management plan between the IDNR and TNC.

In 2016, the fish population in Thompson and Flag Lakes were surveyed by trap nets in March and D.C. boat electro fishing in October. The March trap netting survey used 48 net nights of effort using 1.5-inch mesh nets. 1,523 fish were sampled and represented 17 species and two hybrids. The October boat electro fishing survey used eight stations and a total on-time of 243 minutes. 1,171 fish were sampled and represented 17 species. Overall 23 species and two hybrids were sampled in 2016 by IDNR Fisheries. The survival and recruitment of the state threatened, starhead topminnow (*Fundulus dispar*) was documented.

Increased recruitment was also observed for channel catfish (*Ictalurus punctatus*) and white crappie (*Pomoxis annularis*) populations. The dense submerged aquatic vegetation maintained the diversity of the fish population in 2016. The largemouth bass, bluegill, black crappie, bowfin, spotted gar, shortnose gar, warmouth sunfish (*Lepomis gulosus*), pumpkinseed sunfish (*L. gibbosus*), golden shiner (*Notemigonus crysoleucas*), gizzard shad, brown bullhead (*Ameiurus nebulosus*), black bullhead (*A. melas*), and starhead topminnow populations were stable in 2016. The total exotic fish collected in these surveys were common carp (*Cyprinus carpio*) and a single silver carp (*Hypophthalmichthys molitrix*). In 2016, three white bass (*Morone chrysops*) from 9.4 to 14.2 inches and one silver carp at 20.5 inches were collected during the fall electrofishing sample. These fish were collected in the main ditch in front of the new control structure with the Illinois River. It is highly likely that they entered the Preserve from the Illinois River through the new control structure or from a levee boil during its construction. The size of these fish indicate that they arrived through a large passage like the

control structure. The silver carp had an extremely robust body condition and was a young fish. It appeared to have been in the Preserve growing at an accelerated rate for much of the current growing season. No reproduction and recruitment has been documented at this time. The 2016 fall electrofishing survey continued to document a continued steady decrease in the number of carp collected per hour since the 2012 fall survey. In 2016, fish flesh samples were collected from common carp, bluegill, crappie and largemouth bass for contaminant monitoring. In 2017, IDNR fish management will involve trapnet and electro fishing surveys to document the evolving fish community, the potential collection of brood fish for stocking other restoration sites and the stocking of additional native fish species

Rob Hilsabeck, Illinois Department of Natural Resources

Waterbird and Wetland Monitoring

We monitored the response of wetland vegetation and waterbirds to restoration efforts at Emiquon during 2016 to evaluate restoration success relative to desired conditions under the relevant KEAs. Our primary efforts included evaluating: 1) abundance, diversity, and behavior of waterfowl and other waterbirds through autumn aerial counts and spring ground counts; 2) productivity by waterfowl and other waterbirds through brood counts and nest surveys; 3) the number and type of wetland plant seeds emigrating Emiquon through catch screens in the water control structure; 4) changes in sediment characteristics as a result of drawdown through core sampling and penetrometer measurements; 5) moist-soil plant seed biomass for waterfowl during autumn through core sampling; and 6) composition and arrangement of wetland vegetation communities and associated cover types through geospatial covermapping.

Data was recorded and tabulated from the spring waterbird surveys on a weekly basis. Moist-soil plant seed samples will be sorted, dried, and weighed in Forbes' lab. Duck behavior and brood observations have been tabulated and summarized and wetland vegetation community data have been digitized to create a covermap. Wetland plant and seed emigration samples and sediment cores have been processed and summarized.

Chris Hine, Illinois Natural History Survey, Forbes Biological Station

Metabolizable Energy of Duck Foods

From research done at Emiquon by Forbes Biological Station, the energy content of several different species of submersed and floating leaved aquatic vegetation will be determined for ducks. Aquatic vegetation was collected and its density was determined. Wild gadwall (*Anas strepera*) and mallards (*A. platyrhynchos*) were captured and held in captivity so controlled feeding trials could be carried out to determine the true metabolizable energy. True metabolizable energy estimates will be used to determine the energetic carrying capacity of Emiquon and other wetlands for waterfowl.

Heath Hagy, Illinois Natural History Survey, Forbes Biological Station

Ecology of Marshbirds

The objectives of this project are to; a) investigate breeding ecology of marshbirds, waterbirds, and shorebirds and b) estimate nest density, survival, and success. Other items to be assessed include vegetation quality, water levels, and marshbird occupancy. Nest searches and checks occurred between June and August. Searches took place in Thompson and Flag Lakes.

Heath Hagy, Illinois Natural History Survey, Forbes Biological Station

Banding and Collection of Ducks

Forbes Biological Station captured and leg banded lesser scaup (*Aythya affinis*) and canvasbacks (*A. valisineria*) to generate data regarding their survival, distribution, and recovery rates. Swim-in traps baited with corn were used in water depths of three to six feet near diving duck concentrations. Once ducks began using bait, metal wire traps were placed at bait sites. Traps were monitored at least once daily when active and birds were removed from traps and transported off-site to minimize disturbance, then were processed. Non-target species were released immediately. Little to no use of bait by non-target waterfowl guilds were observed (e.g., dabbling ducks, geese) due to the unfavorable water depths the bait was placed at for these species.

Green-winged teal (*Anas crecca*) and gadwall were trapped and banded using baited swim-in traps, y-confusion traps, panel walk-in traps on dry land, rocket nets, net guns, and floating traps. Swim-in traps were placed in <3 feet of water or on dry land, depending on style. Birds were removed from traps daily or more frequently when necessary, weighed, and assessed for morphological measurements, banded, and a subset fitted with a radio-transmitter weighing less than 3% of their body mass. All trapped birds were held in poultry crates and released simultaneously. An effort was also made to experimentally harvest green-winged teal to determine foraging habitat condition, diet, and food selection. A small camouflaged layout boat was used to observe ducks foraging, approached the birds undetected, and collect the teal. Lethal collection for a relatively small number of these birds using these methods allows concurrent determination of food use and selection, habitat quality relative to food use, and other data vital to understand recent population fluctuations of these species of regional conservation concern.

Heath Hagy, Illinois Natural History Survey, Forbes Biological Station

CH4 and CO2 Measurement Using a Tower at Emiquon

The purpose of this project is to measure methane and carbon dioxide emission from the restored wetland at Emiquon. Data was gathered the first half of the year, and plans are being made for this project to continue in 2017.

Hua Chen, University of Illinois—Springfield

Characterization of sPLA2 from Hymenoptera

The objective of this project is to obtain specimens of *Polistes fuscatus* (paper wasp) to characterize a novel sPLA2 in her venom. 25 *Polistes fuscatus* were obtained, frozen and venom glands dissected. The remaining specimens were incinerated.

Stephen Johnson, University of Illinois—Springfield

Tallgrass Prairie Project

Amy McEuen began a seedling addition experiment in May 2015 with six species of native prairie plants (see table below). All six of these were in the initial seed mix for the Emiquon prairie restorations so they are species TNC wishes to establish in these areas. The objective of this experiment is to see if species that are at the southern end of their range at the restoration site (labeled northern species) will have poorer survival and reproduction than those that are at the northern end of their range (southern species). The hypothesis is that, with climate change, it will be easier for ecologists to reintroduce and establish southern species versus northern species. This is a very difficult hypothesis to test given all the confounding factors other than distribution that can potentially affect establishment. The hope is, however, to at least provide some preliminary data addressing this issue.

Common name	Scientific name	Northern/Southern
Anise Hyssop	*Agastache foeniculum*	Northern
Blue Mistflower*	*Conoclinium coelestinum*	Southern
Rattlesnake Master	*Eryngium yuccifolium*	Southern
Prairie Alumroot	*Heuchera richardsonii*	Northern
Ohio Goldenrod**	*Oligoneuron ohioense*	Northern
Wild Quinine	*Parthenium integrifolium*	Southern

Methods: Seedling survival, growth, and reproduction were measured over both the 2015 and 2016 growing seasons (May-Sept) approximately every three weeks. A few (ten – twenty total) floristic specimens were collected for species that could not be identified in the field and required keying out. They were collected summer of 2016 at Emiquon.

Based on initial analyses, it appears the flooding has negatively affected the floristic quality in some sites. In addition, in 2016 McEuen's Master's student Sarah Lindholm worked with undergraduate student Jack Zinnen to resurvey the transects established in all five prairie restoration sites (16,17,18,19, and 22) in 2008 by Christy Troxell-Thomas. They surveyed fifteen 1 m^2 locations at each site to determine floristic quality – recording both species ID and percent cover.

Amy McEuen, University of Illinois—Springfield

Natural History of Influenza Viruses in waterfowl

Cloacal swabs were collected from hunter-harvested waterfowl for influenza A virus surveillance. Collections took place on 14 different days from September to November 2016 and 488 swabs were taken.

Records kept on each specimen include: location, date, species, sex, age, and specimen collected. Records kept on the study site metadata include but are not limited to: weather conditions, wild avian species present in the immediate area, and general descriptions of species, population density, and proximity of captive birds in the area.

Andrew Bowman, The Ohio State University

Morton Village Excavations

As usual, the bluff top at the north end of preserve was excavated. An area of 39 m2 over site 26 was scraped with a backhoe to expose the house basin. Basin fill was hand excavated to the floor, about 40 cm below surface. The backhoe was also used to strip the plow zone from 3 2x2-m units over site 34 that were then further excavated by hand. Three other 2x2-m units were excavated by hand: on at the edge of site 36 near site 34 and two on the edges of possible structures near St 26.

The 2016 work focused on a full excavation of Structure 26, a domestic building first found in 2016. We also excavated more of site 34, a complex of circular structures or enclosures, and put test units in two possible structures near site 26 and one near site 34. The objectives were to provide data from a completely excavated domestic building, confirm the size and position of the circular wall trenches in site 34, and examine the relationship between site 34 and a domestic building intersecting it.

Mike Conner, Dickson Mounds Museum

Microbial Ecology and Water Quality

The objectives of this project were to document water quality parameters, to take field measurements of the lakes, and determine the microbial diversity since restoration began nine years ago. Bi-weekly sampling of water and sediment were carried out from March through November of 2016. Water samples and sediment await extraction of DNA. Plankton are currently preserved and are awaiting analysis. Water quality analysis has been completed on all samples. The top two cm of surface sediment was collected along with water samples at three pelagic-profundal sites. The degree of disturbance is judged to be minimal as the top sediments primarily represent autochthonous input.

Mike Lemke, University of Illinois—Springfield

Preliminary Examination of Emiquon Mollusks

The molluscan fauna of Emiquon has, until this point received very little attention. The purpose of this project is to identify the common mollusks found both in the aquatic and terrestrial realm in the Emiquon area. An expected outcome of this project is a list of commonly encountered bivalves and gastropods which can be used to inform future studies in the area, along with a reference collection which will be housed at the Therkildsen Field Station. About 50 to 100 dead shells from the Emiquon Preserve were collected. Shells were all surface collected along the perimeter of Thompson Lake and in the Prairie. 2016 collections were from a limited initial survey; more extensive collecting is planned for 2017.

Thomas Rothfus, Therkildsen Field Station

10th Annual Emiquon Science Symposium May 18 and 19, 2016

The Nature Conservancy hosted the tenth Annual Science symposium in 2016 at Big Horse Vineyards. In addition to sharing past and ongoing research, the symposium focused on future research needs and opportunities. The two-day format allowed for a field trip across the wetland, including a tour of the water control structure currently construction, and more time for networking. Emiquon's Key Ecological Attributes were discussed and break out groups met to discuss and later present topics more thoroughly.

The Nature Conservancy Staff

INDIAN BOUNDARY PRAIRIES

Plants of Concern Monitoring at Indian Boundary Prairies

Launched in 2001, Plants of Concern is a long-term rare plant monitoring initiative unique to the region in its use of standardized monitoring protocols used by trained citizen scientists. A program of the Chicago Botanic Garden, Plants of Concern has accumulated a substantial base for analyzing long-term data on a significant number of species and Element Occurrences. Monitors collected data on six state endangered or threatened species at four TNC-owned sites in the Indian Boundary Prairies: Gensburg Markham Prairie (including Markham East, North, and South), Paintbrush Prairie, and Sundrop Prairie.

Plants monitored in 2016 were:
Small white lady's slipper (*Cypripedium candidum*) – 17 plants found at Dropseed Prairie.
Narrow-leaved sundew (*Drosera intermedia*) – 10 plants found at Markham Prairie South.
Small sundrop (*Oenothera perennis*) – 22 plants found at Markham Prairie Complex.
Mountain blue-eyed grass (*Sisyrinchium montanum*) – 400 plants found at Sundrop Prairie:
Sundrop North Subpopulation had 60 plants on 24 May, 2016 and 156 plants on 26 May, 2016,
Sundrop South Subpopulation had 172 plants on 24 May, 2016 and 12 plants on 27 May, 2016.
Eared false foxglove (*Tomanthera auriculata*) – 317 plants found at Gensburg Markham Prairie, 4 plants found at Markham East, 21 plants found across two sub-populations at Markham South, 85 plants found at Paintbrush Prairie.
Grass pink orchid (*Calopogon tuberosus*) – no plants found.

Rachel Goad, Plants of Concern

Endangered Species Monitoring and Hand Pollination of Eastern Prairie White Fringed Orchid (*Platanthera leucophaea*)

Two volunteers monitored plants at three TNC-owned sites in the Indian Boundary Prairies. Volunteers tag blooming orchids with a numbered metal ID tag secured in the ground at the base of the plant. They collect demographic data (plant height, number of flowers, and number of leaves), record herbivory impacts, and record the number of blossoms hand-pollinated. In late summer early fall they record seed capsule development and, if approved previously by the Recovery Coordinator, they may collect pods to distribute at other sites. In 2016, 1/3 of all flowers were hand-pollinated with pollen from other sites that was given to us through the U.S. Fish and Wildlife Service.

2016 monitors Tony Merisko, Elyse Leannaise, and Travis Kuntzelman found two plants at Paintbrush Prairie, six plants and 20 seed pods at Markham Prairie Complex, and 14 plants and 151 seed pods at Sundrop Prairie.

Cathy Pollack, US Fish and Wildlife Service

Benefits of Urban Biodiversity Preserves for Water Storage and Purification

This project is just getting underway, with initial sensor deployment deployed at Indian Boundary Prairies in 2016. Preliminary findings will be presented at the HydroEco 2017 Conference in June 2017. This is planned to be a multi-year study.

Soil sampling was carried out using a 2" diameter soil auger. All excavated soil was removed from the site. Soil sampling depths did not exceed four feet below the ground surface. Surface water level sensor pole installation involved driving a metal signpost into the soil (e.g., within a drainage ditch) with the intent of attaching a sensor to it; for this installation, no soil was removed. Sensor installation involved placing sensors in wells or mounting them to poles that were previously installed as described above.

Water sampling was carried out using five-foot or seven-foot plastic bailers in wells or in surface water. Data collection involved removing the water level sensors from surface water or from groundwater wells and connecting them to a tablet to download data, or connecting the tablet to a data logger for soil moisture probes.

Water sampling and data collection activities were carried out by a team of two or three individuals. Soil sampling events after the initial week in June (27 – 30 June) included up to five individuals.

All sampling sites are geolocated and relevant data about each site and specimen has been archived and is available for public access, including chemical data.

Aaron Packman and Bill Miller, Northwestern University
Cristina Negri and Seth Snyder, Argonne National Lab
Bob Moseley and John Legge, The Nature Conservancy

KANKAKEE SANDS

Plants of Concern Monitoring at Kankakee Sands

Since 2013, four POC monitors have collected data on seven (five state endangered, one state threatened, one regionally rare) species at five TNC-owned sites in the Kankakee Sands: Carl Becker, Hopkins Park Nature Preserve, Mskoda, Pembroke Savannah, and Talmadge Sand Forest. Volunteer involvement in Kankakee County is currently low, but growing. Kankakee Sands staff has been helpful in collecting baseline data on several populations, but Plants of Concern is seeking additional volunteer involvement.

Plants monitored in 2016 were:
Prairie fameflower (*Talinum rugospermum*) – 46 plants found across two sub-populations at Pembroke Savanna

Rachel Goad, Plants of Concern

Bird's Foot Violet (*Viola pedata*) Seed Collection

100 seed pods of *Viola pedata* (bird's foot violet) were collect on 5 June, 2016 from Pembroke Prairie Nature Preserve by William Glass. The pods were cleaned and .105 oz. of seed were planted in a flat. Following germination, the seedlings will be transferred to plant plug trays and grown for one to two years. Eventually the plants will be used to provide seed for further seed production at Midewin National Tallgrass Prairie. The resulting seed will be used in restoration of sandy areas at Midewin. Midewin is planning to attempt a reintroduction of the regal fritillary butterfly and the restoration of bird's foot violet at Midewin will provide host foot plants for the caterpillars.

Bill Glass, Ecologist, USFS-Midewin National Tallgrass Prairie

MACKINAW RIVER PROGRAM

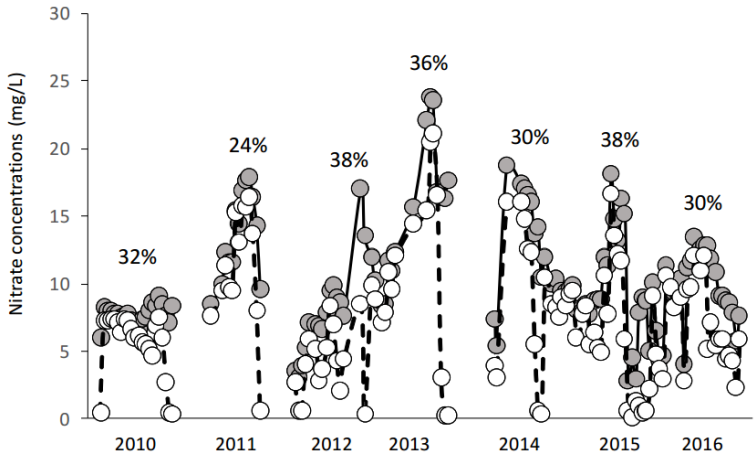
The Mackinaw River maintains some of the highest quality streams in Illinois and provides habitat for 60-70 native fish and 25-30 mussel species. However, like much of the Midwestern United States, land use in the Mackinaw River watershed is primarily row crop agriculture with drainage patterns extensively modified by subsurface tiles that carry high nutrient loads directly from farm fields to nearby stream systems. In fact, Illinois has more total land area drained by tiles than any state in the Upper Mississippi River Basin and contributes some of the highest nitrogen and phosphorus flux to the Gulf of Mexico. The Mackinaw River Watershed Program currently consists of three projects that collectively address three overarching goals to: (1) Improve hydrology and water quality of the Mackinaw River watershed for mussels, fishes, and people who depend on it for water supply and recreation, (2) Reduce nutrient export from the Mackinaw River to downstream river systems, and (3) Develop a model for hydrologic and water quality improvements that is economically viable, compatible with agricultural production, and scalable across the Upper Mississippi River Basin.

Paired Watershed Project

The Nature Conservancy began research on how to improve water quality, restore a natural hydrology, and protect biodiversity at the 10,000-acre watershed scale in late 1999 using a paired watershed design in the headwaters of the Mackinaw river, using the subwatersheds Bray Creek (treatment) and Frog Alley (reference). Our goal is to show water quality and hydrology improvements that can be achieved in these agricultural systems using edge of field and infield conservation practices and consistent monitoring of water quality, flow, and storm event nutrient export. Our past research has shown that more traditional practices (e.g., grassed waterways, stream buffers) are not enough to improve water quality or hydrology in these highly tile-drained agricultural

watersheds. We are currently testing watershed-scale efficiency of constructed wetlands to intercept tile water and reduce nutrient exports from farmland to Bray Creek.

Construction of our seventh wetland was completed in the fall of 2015 in the headwaters of Bray Creek. One wetland was equipped to measure flow and nutrient loadings at the inlet and outlet in 2016. Grab samples have been collected since 2010 from the inlet and outlet of a second wetland that was installed in 2006. Data show that 24% to 38% of annual nitrates are being removed from agricultural tiles that empty into this 11-year old wetland.



Annual mean nitrate reduction in upstream wetland of Bray Creek

Biweekly and storm event sampling of nutrients and suspended sediments in the two subwatersheds of Bray Creek and Frog Alley provides data on how well these seven wetlands work to improve water quality at the watershed scale. In addition, automatic monitoring equipment located throughout each watershed continuously monitor stream hydrology and local weather-related measures such as rainfall, soil moisture, solar radiation, wind speed and direction, and air temperature. We will be focused on increasing several infield practices in the next two years such as cover crops and spring nitrogen application, as well as trying out a new edge of field practice of saturated buffers. This practice also treats tile water as it leaves the field and has great potential as an effective conservation practice.

Research and Demonstration Farm

The Research and Demonstration Farm in Lexington, IL was established in 2004 to promote and demonstrate better management practices on a conventional farm. It is also a research site in which scientists from The Nature Conservancy and the University of Illinois at Urbana-Champaign are investigating the (a) overall effectiveness of constructed wetlands at reducing nutrients in agricultural runoff, (b) wetland to watershed ratio needed in tile-drained agricultural landscapes to significantly reduce nutrient exports from farmland to nearby streams and rivers, and (c) effectiveness of winter cover crops at reducing nitrogen loss to tile drainage systems. Cumulative

results from the last nine years indicate that wetland to watershed ratios of 3%, 6% and 9% will remove 13-31%, 34-39%, and 44-48% of nitrate-nitrogen loadings, respectively. Orthophosphorus loadings were reduced by 43-78% in the smallest wetlands, and up to 93% in the largest wetlands.

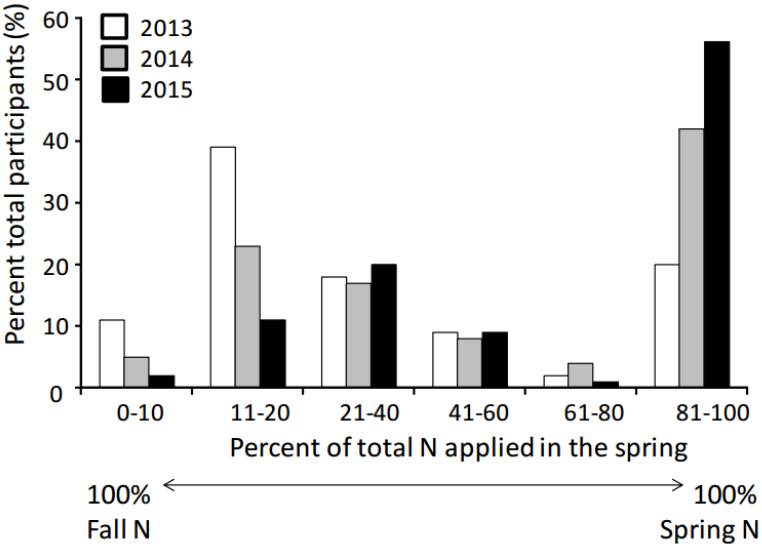
Cover Crop Research - The Franklin Research and Demonstration Farm started its 6th year of cover crop seeding in 2016. In September, a winter cover crop of annual rye grass (25 lbs/acre) and oats (15 lbs/acre) into standing soybeans on 30 acres of the cropland that drains into the East and Gully wetland series. Cover cropped sites are being used as treatment areas and the drainage area of the West wetlands serves as a reference (i.e., no cover crops) as we continue our research on the effectiveness of cover crops at reducing nutrient export from agricultural tiles.

Outreach - Conservancy staff hosted 15 tours at the Research and Demonstration Farm in 2016. New visitors to the Farm included the Illinois Pollution Control Board, North American Prairie Conference attendees, Midwestern BioAg, and the Institute of Energy and Sustainability from Northwestern University. Other tour attendees included university classes, Conservancy staff, University of Illinois Master Naturalist groups, agricultural interest groups, and local farmers and landowners.

Bloomington Drinking Watershed Project

Nature Conservancy science staff are working with the City of Bloomington (City), Natural Resource Conservation Service (NRCS), McLean County Soil and Water Conservation District (SWCD), Farm Service Agency, University of Illinois, Illinois State University, and Conservation Strategies Consultants (CSC) to integrate research from the Paired Watershed Project and the Research and Demonstration Farm into the Bloomington project that addresses water quality concerns associated with local drinking water supply reservoirs of Lake Bloomington and Evergreen Lake. These two reservoirs supply drinking water to roughly 80,000 people in the City of Bloomington, IL, and several surrounding townships. Land use in the two Mackinaw River subwatersheds that supply these reservoirs is 79-93% agricultural and the soils are extensively drained by agricultural tiles. The purpose of the project is to develop and evaluate the effectiveness of a watershed management program that bundles infield practices (nitrogen management, winter cover crops) with edge of field practices (wetlands, saturated buffers) to reduce nutrient export and improve water quality. Our goal is to advance management recommendations that are (a) economically viable, (b) compatible with agricultural production, and (c) transferable to watersheds across the Upper Mississippi River Basin. Most of the practices we are encouraging can be enrolled in USDA Farm Bill programs that pay up to 90% of the implementation expenses.

In 2016, McLean County SWCD received funding from Illinois EPA 319 Program to transition 3000 acres in the Bloomington watershed from fall to spring nitrogen application over the next two years. We estimate that this addition of 3000 new spring-applied acres to the current spring applied acres will represent about 14% of the total farmed acres in the watershed.



Changes in timing of nitrogen application from fall to spring among Farmer Network participants in the Bloomington watershed

This work to promote more spring application of nitrogen fertilizer builds on our experience coordinating a Farmer Network

program that was funded through a Conservation Innovation Grant and Environmental Defense Fund in Lake Bloomington and Evergreen watersheds from 2013 to 2015. We worked in collaboration with the City, SWCD, and NRCS to enroll 44 to 88 fields (approximately 2500-5000 acres) each year of the program. The Network provided farmers with evaluative tools such as cornstalk and soil nitrate testing, aerial imagery of crop production, replicated strip trials, and a networking forum for information exchange. On-farm evaluations provided real time data analyses to farmers on how fields respond to nutrients and the economic implications of nutrient applications so that they could evaluate how to refine nitrogen management on their fields. Data from this program showed that the percentage of participants that applied 80-100% of anhydrous nitrogen in fall declined between 2013 and 2015, and that the percentage of those that applied 80-100% in the spring increased.

A subset of producers, landowners, and farm managers from the Farmer Network was organized into an Agricultural Advisory Group in 2014 and continues to advise the Conservancy and partners how to scale up conservation in agricultural watersheds in a way that protects the environment and that makes economic sense to landowners and producers. We also continue to work with CSC to advance the development of a Bloomington Water Fund. Terry Noto (president of CSC) is an attorney and former consultant for Environmental Defense Fund. Mike Linsenbigler is former Deputy Director of the Conservation and Environmental Programs Division for Farm Services Agency in Washington, D.C.

The following is an update of the work by TNC and partners in 2016 for the Bloomington Drinking Watershed Project:

- Hired a water quality project manager, Adrienne Marino, to add capacity to the Bloomington project team.
- Completed construction of 3 new wetlands in Money Creek watershed on private farm ground for a total of seven wetlands in the watershed.
- Installed monitoring equipment at the inlets and outlets of six of the seven constructed wetlands. This fulfilled one of our deliverables for the Conservation Innovation Grant to construct and monitor 6 wetlands in the watershed.
- The Bloomington watershed was selected as a priority watershed for NRCS National Water Quality Initiative funding. This Initiative is targeted at improving water quality in small watersheds impaired by agricultural use that are listed on a state's Clean Water Act Section 303d list of impaired watersheds. Initiative funds will be available to update the Lake Bloomington watershed plan in 2017 and to implement management actions through NRCS's Environmental Quality Incentives Program (EQIP) funds in 2018.
- Disseminated newsletter to 250 agricultural landowners introducing a new incentive program for saturated buffers through USDA's Conservation Reserve Program and EQIP.
- Initiated planning for a 2017 Summer Field Day to demonstrate several new practices (split-application of spring nitrogen, saturated buffer), as well as constructed wetlands.
- Contracted with Dr. Joan Brehm (Illinois State University) to conduct a survey of agricultural producers and landowners in the Lake Bloomington and Evergreen watersheds in early spring 2017
- With NatureVest, hosted a Packard Fellow MBA intern at TNC's Chicago office. Heather

Wiggins, a joint Environmental Management and Business Administration Master's degree student at Duke University, developed a business model for the Bloomington Water Fund and researched market conditions beyond Bloomington to develop a plan to scale the business strategy across the Midwest.

- Continued to hold monthly Bloomington work group meetings to discuss progress, next steps, and new opportunities.
- Funding: Funding was secured for the Bloomington project through June 2018 from Anne Ray Foundation as part of a larger grant to TNC's Global Water Program. Funding was also secured through June 2018 from the Walton Family Foundation. McLean County SWCD secured IL EPA 319 funding through spring 2019 to move 3000 acres from fall- to spring-applied nitrogen.
- Outreach: Mackinaw staff hosted three tours in the Bloomington Drinking Watershed project in 2016 to visit new CP39 wetlands on private farmland and City of Bloomington property. Two of the tours were hosted for media outlets that included WGLT radio and the Illinois Farm Bureau Partners magazine.
- Next steps: (a) Work with SWCD to increase spring nitrogen application (b) Coordinate with NRCS, SWCD and partners to update the Lake Bloomington watershed plan (c) Integrate watershed mapping, monitoring and economic studies into the updated plan (d) Further develop the Agricultural Advisory Group to help direct and promote watershed conservation program (d) Integrate survey results into outreach strategy (e) Coordinate and implement 2017 Summer Field Day.

Krista Kirkham, Maria Lemke, Adrienne Marino, Ashley Maybanks, The Nature Conservancy

MIDEWIN NATIONAL TALLGRASS PRAIRIE (MNTP)

Grassland Bird Survey at MNTP

Grassland bird monitoring has been going on prior to the legislation creating Midewin National Tallgrass Prairie while the land was still being managed by the Army. The Forest Service with help from partners has been increasing the amount of grassland habitat at Midewin. The Midewin staff, with help from TNC and IDNR staff, has been modifying the protocol to meet the expanded acres of grassland and to provide better estimates of the populations of grassland birds. The data below represents birds seen within a 100–meter radius survey points within five minutes and the data is presented as birds per 100 survey points. Prior to 2008, there was not an area dimension to the point counts and double counting of birds was much more likely.

For rarer birds with small populations, it is possible to have no birds per 100 points on some occasions. For those species with large enough populations to see trends, it appears the populations are stable, but there are fluctuations over time. The upland sandpiper (*Bartramia longicauda*) population has been declining over the years and no upland sandpipers were seen in 2016. The 2016 data was collected June 6–8.

Grassland Bird Survey Data

Species	2009	2010	2011	2012	2013	2014	2015	2016
	Birds/ 100 pts	Birds/ 100 pts	Birds/ 100 pts	Birds/ 100 pts	Birds/ 100 pts	Birds/ 100 pts	Birds/ 100 pts	Birds/ 100 pts
Upland Sandpiper	5.2	0.4	4.8	1.3	1.3	0.0	0.0	0.0
Bobolink	106.0	115.2	152.7	106.4	127.1	103.0	121.1	144.0
Dickcissel	238.8	189.6	244.3	231.1	167.2	214.8	198.0	240.7
Grasshopper Sparrow	152.6	127.8	159.0	99.7	94.0	117.2	109.2	117.0
Eastern Meadowlark	159.9	164.8	160.8	165.1	171.2	187.6	133.6	148.4
Henslow's Sparrow	20.3	35.9	36.6	41.7	20.7	27.2	30.9	37.4
Savannah Sparrow	21.1	25.9	21.6	15.4	24.2	10.1	17.1	23.1
Vesper Sparrow	0.4	0.0	0.7	5.8	1.0	1.2	0.0	1.1
Sedge Wren	1.7	3.0	1.1	3.2	0.3	0.0	0.0	3.8

Bill Glass, Ecologist, USFS-Midewin National Tallgrass Prairie
Jim Herkert, Illinois Audubon

Loggerhead Shrike Research at MNTP

The breeding population of Loggerhead Shrike (*Lanius ludovicianus*) at Midewin National Tallgrass Prairie has been monitored from 2005 to 2016. The population demographic data collected includes population size, age structure, and reproductive success. Banding of adult shrike was conducted annually, with some additional effort focused on nestlings (2005-2007) and independent hatch year birds (2014-2016). Return rate of young and adults, site re-use, site fidelity,

and dispersal distance were assessed. Population size ranged from 4 to 14 breeding pairs, with additional single non-breeding birds located in most years. Reproductive success ranged from 50% to 100%. While first nests were often unsuccessful, most pairs fledged young. Site re-use was high, and appears related to nesting success in the preceding year, suggesting that shrike use post-breeding information when selecting nest sites. The ratio of second year (SY) (first year breeder) to after second year (ASY) birds varied by year and among sex, with larger than expected numbers of SY female birds. Average natal dispersal was 0.97 km, and average adult dispersal distance 1.6 km. Female dispersal distance was slightly greater than that of males (2.1 km versus 1.3 km). Most of the known population was banded at the end of each breeding season, but usually only one-third of the population carried bands at the start of the subsequent breeding season. Population size and trend appears correlated with number of ASY birds, and immigration rates.

The Midewin Alliance, The Nature Conservancy, and the Illinois Department of Natural Resource's Wildlife Preservation Fund provided financial support. This research has also been funded in part through grants or scholarships in support of Dr. Chabot's PhD research under the supervision of Dr. Stephen Lougheed, Queen's University. A special thanks to the Midewin staff and volunteers who assisted with fieldwork and to Renee Thakali for support of this work.

Amy Chabot, Avian Ecologist, Researcher

Breeding Bird Monitoring at MNTP

TNC staff is responsible for recruiting, scheduling trainings, and entering data. Monitors surveyed their sites three – five times over the breeding season (mid–May to mid–July) and recorded all bird species they recognize by sight or song. Monitors create routes that cover the entire assigned area, which could be up to 300 acres each. In 2016, sixteen volunteers contributed a total of 149 hours for training and monitoring birds. In the breeding bird survey, volunteers identified 100 different species of birds on twelve Midewin sites. The volunteers are especially useful for Midewin staff since some areas not covered by the grassland bird monitoring are covered. Some of the birds recorded by volunteers include: black-billed cuckoo (*Coccyzus erythropthalmus*), red-headed woodpecker (*Melanerpes erythrocephalus*), scarlet tanager (*Piranga olivacea*), yellow-billed cuckoo (*Coccyzus americanus*), blue grosbeak (*Passarina caerulea*), Bell's vireo (*Vireo bellii*), and yellow-breasted chat (*Icteria virens*). These birds and others would have been missed on the grassland bird surveys.

Data posted on Midewin's website at:
https://www.fs.usda.gov/detail/midewin/workingtogether/volunteering/?cid=stelprdb5365263

Allison Cisneros, Kathryn Gorman, The Nature Conservancy
Bill Glass, Ecologist, USFS-Midewin National Tallgrass Prairie

Butterfly Monitoring at MNTP

TNC staff assists in recruiting volunteers, scheduling trainings, and compiling data for the butterfly–monitoring program at Midewin. The Illinois Butterfly Monitoring Network establishes the protocols. In 2016, two volunteers contributed a total of 33 hours for monitoring butterflies on one Midewin site. Volunteers identified 34 different species of butterflies.

Data posted on Midewin's website at:
https://www.fs.usda.gov/detail/midewin/workingtogether/volunteering/?cid=stelprdb5368200

Allison Cisneros, Kathryn Gorman, The Nature Conservancy
Doug Taron, Director of the Illinois Butterfly Monitoring, Peggy Notebaert Nature Museum

Frog Monitoring at MNTP

TNC staff facilitates this monitoring program in the areas of recruitment, training, and data compilation using Chicago Wilderness protocols. In 2016, 26 volunteers monitored frogs on 18 wetland sites on Midewin. These volunteers were trained to listen for the unique mating calls of eight different species of frogs during their breeding season. Midewin's dedicated force of frog monitors spent a total of 172 hours for training and on–site monitoring from mid–March to late July recording their observations. Along with identifying and quantifying the frog calls, monitors were asked to document conditions such as temperature, noise, wind, and sky clarity. Nighttime monitors often comment on other nocturnal wildlife experiences such as the call of snipes, nighthawks, soras, and bitterns.

Data posted on Midewin's website at:
https://www.fs.usda.gov/detail/midewin/workingtogether/volunteering/?cid=stelprdb5355893

Allison Cisneros, Kathryn Gorman, The Nature Conservancy
Bill Glass, Ecologist, USFS-Midewin National Tallgrass Prairie

Plants of Concern Monitoring at MNTP

TNC staff assists in recruiting volunteers for the Plants of Concern program at Midewin. Plants of Concern, coordinated by the Chicago Botanic Garden (CBG), is a rare plant monitoring program designed to gather data over time to learn population trends in relation to management practices. In addition to CBG volunteers, eight Midewin volunteers contributed 137 hours for training and field monitoring of ten rare plants in 2016. Among them are earleaved false foxglove (*Tomanthera auriculata*), white lady's slipper (*Cypripedium candidum*), limestone or glade quillwort (*Isoetes butleri*) and Hill's thistle (*Cirsium hillii*).

Volunteers flagging eared false foxglove, *Tomanthera auriculata*

Michelle Pearion, Botanist, USFS-Midewin National Tallgrass Prairie
Rachel Goad, Plants of Concern Manager, Chicago Botanic Garden
Kim Elsenbroek, Plants of Concern Research Assistant, Chicago Botanic Garden

Floristic Quality Monitoring at MNTP

TNC staff is responsible for recruiting, entering data, and coordinating logistics for this volunteer program. The CBG research assistant leads the individual monitoring dates along with Midewin staff. Midewin volunteers currently conduct these surveys at the South Patrol Road, Blodgett, and Rt. 66 prairie restoration areas.

Volunteer floristic quality monitors in Route 66 Prairie

Now that Midewin has good baseline data, volunteers will alternate the restoration areas monitored annually. Midewin will also add new restoration areas to this monitoring rotation. In 2016, 15 volunteers contributed 315 hours to monitoring these sites and assisting with data processing. Because of its high diversity, the Grant Creek Nature Preserve on the Des Plaines Conservation Area property was surveyed and analyzed in 2006 for its Floristic Quality Index (FQI) to serve as a goal for Midewin's sites.

Annual surveys will determine if Midewin's current restoration management processes are resulting in increased levels of species diversity. Site mean FQI values are listed in the table below.

Floristic Quality Monitoring Data

Site	2006 FQI	2007 FQI	2008 (no data collected)	2009 FQI	2010 FQI	2011 FQI	2012 FQI	2013 FQI	2014 FQI	2015 FQI	2016 FQI
Grant Creek Natural Area – Des Plaines Conservation Area	17.53	-	-	-	-	-	-	-	-	-	-
Blodgett Road Dolomite Prairie	10.65	-	-	-	-	-	-	-	-	-	-
ExxonMobil	-	7.37	-	-	-	-	-	-	-	-	-
South Patrol Rd.	8.36	9.89	-	12.70	14.09	13.95	13.83	-	12.65	12.38	12.34
Rt. 66	4.66	6.28	-	9.19	9.97	10.58	10.70	-	10.89	-	12.06
Blodgett Road Restored Area	-	7.24	-	-	9.11	10.02	10.48	10.46	-	9.81	9.64

Full data posted on Midewin's website at:
https://www.fs.usda.gov/detail/midewin/workingtogether/volunteering/?cid=stelprd3801501

Allison Cisneros, Kathryn Gorman, The Nature Conservancy
Michelle Pearion, Botanist, USFS-Midewin National Tallgrass Prairie
Jennifer Durkin, Native Plant Specialist, USFS-Midewin National Tallgrass Prairie
Rachel Goad, Plants of Concern Manager, Chicago Botanic Garden
Kim Elsenbroek, Plants of Concern Research Assistant, Chicago Botanic Garden

Federally Endangered *Dalea foliosa* Monitoring at MNTP

Monitoring the federally endangered leafy prairie clover (*Dalea foliosa*) provides data to detect changes in the population over time. In recent years, the populations at Midewin have increased and monitoring by staff alone has become challenging. As a result, eight volunteers assisted with monitoring plants in 2016. Volunteers count individual plants and collect demographic data such as number of vegetative stems, reproductive stems, stems with aborted inflorescences, and total inflorescences, as well as any herbivory or damage present.

In 2016, eight volunteers contributed 67 hours to monitoring. Monitors counted over 3,000 plants at one subpopulation.

Michelle Pearion, Botanist, USFS-Midewin National Tallgrass Prairie
Jennifer Durkin, Native Plant Specialist, USFS-Midewin National Tallgrass Prairie

RiverWatch Monitoring at MNTP

TNC staff assists in recruiting volunteers and scheduling training for the RiverWatch program at Midewin. Illinois RiverWatch is coordinated by the National Great Rivers Research and Education Center (NGRREC). Volunteers are certified to collect and identify stream macroinvertebrates and other scientific data that is used to gauge long–term trends in stream health, develop land management strategies, and identify potentially degraded waters. In 2016, 22 volunteers spent 104 hours (including training and lab identification) on nine Midewin sites. The 2016 Illinois RiverWatch Program Report rated two sites on Prairie Creek and one site on Grant Creek among the ten best RiverWatch sites in the state. Additionally, sites on Jackson Creek, Grant Creek and Prairie Creek were found to have an improving overall water quality trend over time, 3 of the 14 sites statewide so identified.

RiverWatch monitoring
Midewin Hydrologist, Jeff Tepp (middle) with volunteers Becky Blankenship and Luke DeRudder

Allison Cisneros, Kathryn Gorman, The Nature Conservancy
Jeff Tepp, Hydrologist, USFS-Midewin National Tallgrass Prairie

Water Quality Monitoring at MNTP

Several volunteers from Midewin's RiverWatch team have expanded their efforts to collect additional water quality data such as phosphate levels, turbidity, temperature, pH, dissolved oxygen, conductivity, nitrates, and velocity. In 2016, 26 volunteers spent 187 hours monitoring. This entails teams of three collecting physical and chemical measurements of stream flow twice a month from April to October. Currently there are five monitoring locations: three on Prairie Creek, one on Grant Creek and one on Jordan Creek.

Allison Cisneros, Kathryn Gorman, The Nature Conservancy
Jeff Tepp, Hydrologist, USFS-Midewin National Tallgrass Prairie

NACHUSA GRASSLANDS

Animal Responses to Prairie Restoration at Nachusa Grasslands

To assess the success of restoration and management a variety of animal taxa are being monitored at The Nature Conservancy's Nachusa Grasslands (Lee and Ogle Co., IL).

Abundance, movements, and habitat use by Blanding's turtles

The Blanding's turtle (*Emydoidea blandingii*) is an Illinois state endangered species. Its conservation and management is made challenging by a long life span and its use of large expanses of both wetland and upland habitat. Records of Blanding's turtles at Nachusa Grasslands are sparse, with just seven element occurrences between 1990 and 2008. To better characterize the status of Blanding's turtles at Nachusa Grasslands, T. Anton and D. Mauger conducted 6-10 days of trapping during 2014, 2015, and 2016. When captured, Blanding's turtles are individually marked, measured, weighed, and classified by sex. In 2016, a radio telemetry study of six Blanding's turtles was initiated to obtain information on movements and habitat use.

Abundance: Since 2014, a total of nine adult Blanding's turtles (six females, three males) have been documented at Nachusa Grasslands (see table below).

ID	Sex	Mass (g)	Carapace Length (mm)	2014	2015	2016
A. Adults						
1L1R	Female	1200	200.0	✓	✓	✓
1L2R	Female	1185	205.5		✓	✓
1L3R	Female	1230	199.0		✓	✓
1R8R	Female	1030	189.0		✓	✓
1R9R	Male	1600	223.0		✓	✓
1L8R	Female	1070	183.0		✓	✓
1L9R	Female	983	185.5			✓
1L10R	Male	1430	224.5			✓
1L11R	Male	1420	222.0			✓
B. Hatchlings						
2R		11.1	38.4			
3R		9.9	36.8			
8R		9.8	37.2			
9R		10.7	37.4			
10R		9.7	37.7			
10L		10.6	38.3			
9L		10.1	38.3			
8L		10.5	37.5			
3L		10.3	37.4			

Capture histories and size of nine adult Blanding's Turtles at Nachusa Grasslands (A) and size of nine hatchling (B) Blanding's turtles at Nachusa Grassland. Animals listed in bold were fitted with radio transmitters in spring (adults) or fall (hatchlings) 2016. Mass and carapace lengths were obtained upon first capture or hatching in 2016.

Movements: Radio telemetry of these six animals demonstrated their use of wetland and upland habitats associated with the Franklin Creek corridor on both TNC and adjacent property, including locations previously not known. Home ranges varied from 5 to 39 ha. Of the five turtles initially captured at Tellabs Savanna, only one, a female, restricted its movements to TNC property. One female was found to be missing her right hind leg. This appears not to have affected her inability to move, but may interfere with nesting behavior as females use their hind legs to excavate nest cavities.

Reproduction: Palpation in late May and early June indicated that all five females contained eggs. Two females were tracked to nest sites and nests were protected using hardware cloth enclosures. Nest enclosures were monitored daily during late summer and hatchlings were released at maternal wetlands. Two other females were tracked to upland sites and presumably nested, but nest sites were not detected. No upland movements were observed for the remaining female.

Eight hatchlings from the nest of one female were tracked using mini-transmitters until cold temperatures caused turtles to largely cease moving. Data from these hatchlings will be combined with those from a parallel study of Blanding's turtle hatchlings at sites in Kane County to estimate survival and characterize movements.

Hatchling Blanding's turtles outfitted with radio transmitters. September 2016.

Batteries affixed to adult Blanding's turtles are expected to function through spring 2018 and additional transmitters may be deployed in 2017. This will provide further data on nest site selection, allow nests to be protected, and ensure that additional hatchlings successfully find their way to maternal wetlands.

Age Structure: Aside from hatchlings that emerged from protected nests, no juvenile Blanding's turtles have been encountered at Nachusa Grasslands. This suggests that recruitment may be low, a concern for Blanding's turtles elsewhere where low recruitment may threaten population persistence.

Occurrence of Tiger Salamanders at Nachusa Grasslands

The tiger salamander (*Ambystoma tigrinum*) remains the only salamander species documented at Nachusa Grasslands. Adults spend much of the year in burrows or under logs and rocks and are encountered infrequently. Breeding occurs in early spring, primarily in fish-free ponds, and larvae transform into terrestrial juveniles in late summer or autumn.

At Nachusa Grasslands, adult tiger salamanders have been observed in the Thelma Carpenter unit in 2009 and 2013 and in 2015 and 2016 and in the Stone Barn unit in 2016. Approximately 40 egg masses were located in a small pond within the Thelma Carpenter unit on 22 March, 2016. A search for egg masses in more centrally located wetlands within Nachusa Grasslands on 22 March, 2016 was unsuccessful. However, additional searches are warranted.

Long-term Monitoring of Grassland Snakes in a Restoration Chronosequence

To assess the effects of restoration age and fire history on occupancy by grassland snakes, coverboard arrays were deployed in units restored along a chronosequence of dates ranging from 1988 – 2012. Within each unit, cover boards were placed at 20m intervals in a single row or in two rows separated by 50m. Cover boards were checked approximately weekly from May – October in 2013 – 2016. Snakes were hand captured, identified to species, measured to obtain snout-vent length and mass, classified by sex and reproductive status, individually marked, and released within five minutes of capture.

Four species were encountered regularly during the study: fox snakes (*Pantheropis vulpinus*), Dekays's brownsnakes (*Storeria dekayi*), plains garter snakes (*Thamnophis radix*), and common garter snakes (*Thamnophis sirtalis*). From 2013 – 2016, 16,268 cover board checks resulted in 139 fox snake captures, 437 Dekays's brown snake captures, 106 plains garter snake captures, and 596 common garter snake captures within the 12 restoration units. Two other species, racers (*Coluber constrictor*) and milk snakes (*Lampropeltis triangulum*) were encountered infrequently.

Occupancy by the four common species all increased throughout the study, from three to eleven units for fox snakes, from six to nine units for Dekay's brownsnakes, from four to nine units for plains garter snakes, and from eight to twelve units for common garter snakes (see table below). More formal analyses of occupancy that account for variation in month, search effort, fire history, and restoration age are planned. Data collected in this study is also being used to characterize diet and growth among grassland snakes.

Unit	*Pantherophis vulpinus*				*Storeria dekayi*				*Thamnophis radix*				*Thamnophis sirtalis*			
	2013	2014	2015	2016	2013	2014	2015	2016	2013	2014	2015	2016	2013	2014	2015	2016
CE	0	0	1	1	0	1	1	1	1	1	0	1	1	1	1	1
CW	0	0	1	1	1	1	0	1	1	1	1	1	1	1	1	1
FC	0	0	0	1	1	1	1	1	0	0	0	0	1	1	1	1
HE	0	1	1	1	0	0	0	1	0	1	1	1	1	0	1	1
HN	-	1	1	1	-	0	0	0	-	0	1	1	-	0	1	1
HS	1	0	1	1	0	0	1	0	0	1	0	1	0	1	1	1
HW	1	1	1	1	0	0	0	0	0	0	0	0	0	1	1	1
MU	0	1	1	0	1	1	1	1	0	1	0	1	0	1	1	1
SB	0	1	1	1	0	0	1	1	1	0	0	1	1	1	1	1
SF	1	0	1	1	1	1	1	1	0	0	0	1	1	1	1	1
TC	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
WH	0	0	0	1	1	1	1	1	0	0	0	0	1	1	1	1
Total	3	6	10	11	6	7	8	9	4	6	4	9	8	10	12	12

Occupancy (uncorrected for detection probability) of restoration units by Fox snakes, Dekay's brownsnakes, Plains garter snakes, and Common garter snakes. Presence is indicated by a '1;' apparent absence is indicated by a '0.' 'Total' refers to the total number of restoration units (out of 11 in 2013 and out of 12 in other years) in which a species was known to be present.

Cover Board Surveys of Small Mammals in a Restoration Chronosequence

While checking cover boards for snakes, small mammals were sometimes seen using the boards as a retreat and as nesting sites. This observation suggests that cover boards might provide an alternative to live-trapping for small mammal sampling. Possible advantages to this include the ability to sample shrew species (*Blarina*, *Sorex*) that enter live traps infrequently and face risk of starvation (*Sorex*) if they do. Disadvantages include the inability to distinguish between species (*Peromyscus leucopus* vs. *P. maniculatus*; *Microtus pennsylvanicus* vs. *M. ochrogaster*) or mark and measure individuals.

The number of small mammals observed was recorded during approximately weekly board checks from May – October in twelve units representing a chronosequence of time since restoration from 1988 to 2012. Mammals were identified to genus (mice, *Peromyscus* sp.; voles, *Microtus* sp.) or species (Northern short-tailed shrew, *Blarina brevicauda*; Masked shrew, *Sorex cinereus*). Restoration units were scored for presence or absence, not accounting for the probability of detection. Units were also scored for relative abundance. Because small mammals were not captured and individually marked, summing observations across weeks likely yields biased estimates of abundance (e.g. nesting females might be counted in multiple weeks). Instead, relative abundance was computed as the number of boards (from 0 – 20) within a unit under which a given genus or species was observed at least once. For comparison, data on occupancy and abundance (minimum known alive; the number of unique individuals captured in a given unit) based on live trapping were obtained from H. Jones, A. Burke, and colleagues.

For mice (*Peromyscus leucopus* and *P. maniculatus* combined), live trapping and cover boards provided similar estimates of occupancy and highly correlated estimates of relative abundance. Live trapping and cover boards provided differing estimates of occupancy for other small mammal species. Voles (*Microtus pennsylvanicus* and *M. ochrogaster* combined) were detected via live trapping in eight units in 2015 and four units in 2016 but via coverboards were detected in four

units in 2015 and one unit in 2016. Masked shrews were undetected by live trapping but were detected by cover boards in seven units in 2015 and eleven units in 2016. Similarly, Northern short-tailed shrews were detected by live trapping in four units in 2015 and three units in 2016 but by cover board in nine units in 2015 and eleven units in 2016.

The similarity in measures of occupancy and relative abundance for mice suggests that cover board surveys may be a useful way to monitor small mammal responses to restoration. This may be especially true for shrew species. Because they are insectivores, shrews are less likely that seed-eating mice and voles to enter live traps baited with oats or other plant-based material. More formal analyses of occupancy based on cover board surveys that account for variation in search effort, fire history, and restoration age are planned.

Slug Abundance in a Restoration Chronosequence

Terrestrial slugs are voracious consumers of plant material (including seedlings) and are an important food source for vertebrates, including Dekay's Brown snake, a common grassland snake species. In fall, 2015, a pilot study to assess the abundance of slugs within restoration units differing in age was carried out with the help of NIU undergraduates S. McDonald and E. Virgin.

Slug traps were deployed in the twelve units included in snake and small mammal surveys and in four other units, an agricultural field adjacent to the Stone Barn unit, a recent (2013) restoration unit referred to as Holland Farm, the Main Unit Remnant and the Thelma Carpenter Remnant. Three pairs of slug traps were deployed in each unit and consisted of four-ounce portion cups buried flush with the ground surface and filled ca. 1/3 full with beer. Slugs are attracted to the beer, enter traps and drown. These were preserved in ethanol, counted, identified, and weighed.

Traps were deployed for 24 hours on two occasions within each unit (12 or 20 September 2015 – 8 units on each date and 26 September 2015 – all 16 units). A total of 906 slugs were captured. Slugs all belonged to a single non-native species, *Deroceras* sp., the gray garden slug. Across units, slug numbers (slugs per trap) and slug biomass was highest in units of intermediate age.

Numbers of slugs captured varied greatly between dates (182 on 12 and 20 September vs 724 on 26 September) and may vary seasonally and among years. Thus, replicating this study over a longer sampling period would be necessary to better characterize slug abundance and biomass.

Camera-trap Surveys of Mesopredators in Restoration Chronosequence

To test the feasibility of using camera traps to monitor mesopredators (coyotes, foxes, raccoons and other similar-sized species), trail cameras were deployed in 16 restoration units for two one-week periods in spring 2016 with assistance by NIU undergraduates S. McDonald and E. Virgin.

Eight cameras were deployed at a time between 1 April and 29 April. Cameras were mounted about 50 cm above the ground facing north. A scent stick was placed about three m in front of each camera and was 'baited' with commercial scent used in fur trapping. Hardware problems and disturbance by bison sometimes reduced the number of days that cameras were functional. Images of deer were captured most frequently; images of coyotes were also frequent; skunks, raccoons, and turkeys were uncommon. These results suggest that camera traps may be useful in surveys of mesopredators.

Richard B. King, Northern Illinois University

Bison Diet Preferences and Impacts Using Drones and Stable Isotopes

This was the first year of gathering data for all parts of this project including: isotope samples from bison hair and three leaves each from the following plant species: *Symphyotrichum ericoides, Bromus inermis, Solidago canadensis, Koeleria macrantha, Anemone cylindrical, Melilotus officinalis, Melilotus alba, Baptisia alba macrophylla, Dichanthelium oligosanthes scribnerianum, Salix humilis, Echinacea pallida, Tradescantia ohiensis, Achillea millefolium, Baptisia bracteata, Astragalus canadensis, Andropogon gerardii, Elymus canadensis, Trifolium pretensa, Euphorbia corollata, Sporobolus heterolepis, Phalaris arundinacea, Daucus carota, Desmodium illinoense, Poa pratensis, Carex bicknellii, Lespedeza capitata, Setaria pumila, Salix interior, Juncus interior, Dalea candida, Phleum pretensa, Chamaecrista fasciculata, Agrostis gigantean,* and *Zizia aurea*; aboveground biomass; vegetation surveying; and unmanned aerial vehicle (UAV) and ground-truthing images. This first year was a chance to test the methods for UAV flight planning and image processing and to set baseline data for all parts of the project. All data has been collected for isotope analysis and the vegetation samples have been processed. Bison hair is still being processed so the results are not yet available. UAV flight planning and image analyzing techniques are still being refined.

Preliminary Results:

1. Aboveground biomass decreases with grazing and time since restoration.
2. There is no difference between plant diversity between sites with bison and sites without.

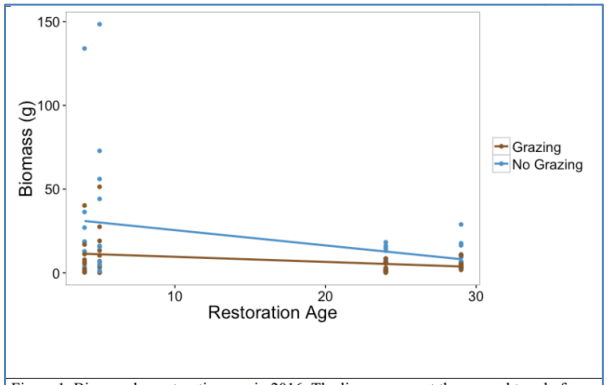


Figure 1. Biomass by restoration age in 2016. The lines represent the general trend of biomass across restoration age for both grazed (brown) and not grazed (blue) sites. The points represent individual measurements from each sampling quadrat ($0.1m^2$)

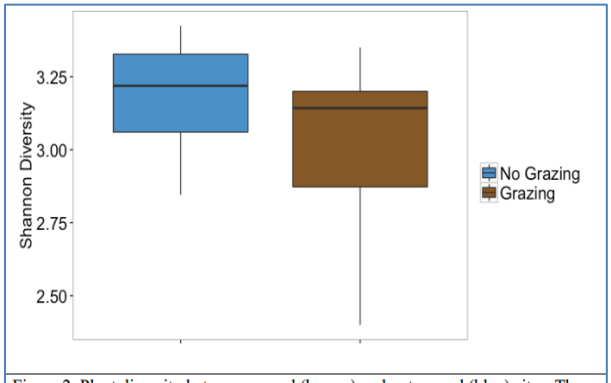


Figure 2. Plant diversity between grazed (brown) and not grazed (blue) sites. The lines in the boxes represent the median of the data.

Holly Jones and Ryan Blackburn, Northern Illinois University

Effect of Management on Native Bee Communities of Restored Tallgrass Prairie

Since 2013, we have annually sampled bee communities along a 26–year chronosequence of restored tallgrass prairie at Nachusa Grasslands to evaluate whether bee abundance, species richness, and community composition in restored habitat is similar to that of remnant prairie, and to investigate patterns in community development over time.

In 2016, we added to our dataset by conducting eight rounds of sampling from May–August, collecting 2,329 bee specimens of 72 species. Each sampling round consisted of passive bee sampling at restored prairie, remnant prairie, and nearby agricultural sites, as well as floral diversity and abundance surveys at each site. These data will be used to further our understanding of bee abundance, richness, and composition patterns over time at Nachusa. We are using these data in combination with our 2015 data to test whether the reintroduced bison affect bee communities in restored prairie, and whether these effects and those of other management practices are directly or indirectly impacting bees. We will present our next set of results in two talks at the annual meeting of the Ecological Society of America in Portland, OR in 2017.

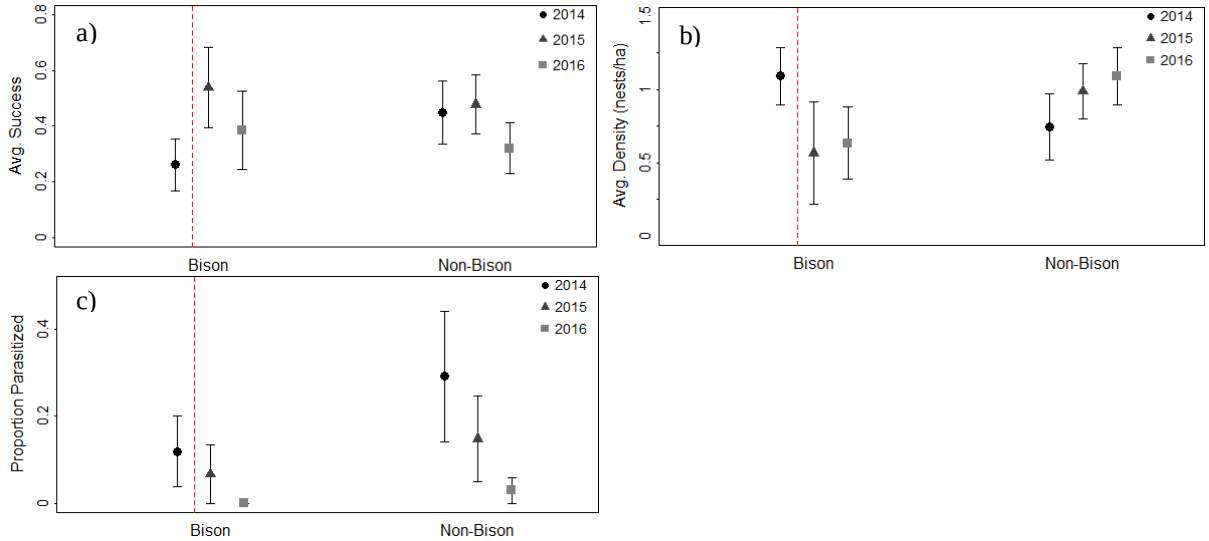
Bethanne Bruninga-Socolar, Rutgers University
and Sean Griffin, North Carolina State University

The Effects of Bison Reintroduction, Prescribed Fire, and Time Since Restoration on Grassland Bird Nest Success in a Tallgrass Prairie

Natural Nest Survey

Fifty-three from twelve different grassland bird species were found between May and July 2016. Five of these nests were unidentifiable. Forty-one nests have adequate data and were added to the 79 nests from the last two seasons. Thirty-four percent of these nests were successful. There was a large variation in success across species and most of these nests were found in the incubation stage. However, nests found in the nestling stage had a higher probability of surviving. Figure a shows the average nest success between the bison and non-bison sites for each year.

Similar numbers of nests were found in the bison and non-bison units this year compared to last year (Figure b). In addition, more nests were found in the younger plantings and similar numbers in older plantings and remnants, but nest success was similar for each type (F=1.672,50; p=0.199). Only one nest was found parasitized by a brown-headed cowbird (*Molothrus ater*) in a site that had no bison (Figure c); however, some of these nests were found in a stage where parasitism could not be assessed and could alter this proportion. Burn frequency changed for each site this year and more nests were found in areas that were burned in the spring than in the fall or the previous year, but success was not correlated with fire return interval (t=-0.57, df=51, p=0.95). Average success varied randomly, and most species had a wide variation in visual obstruction.



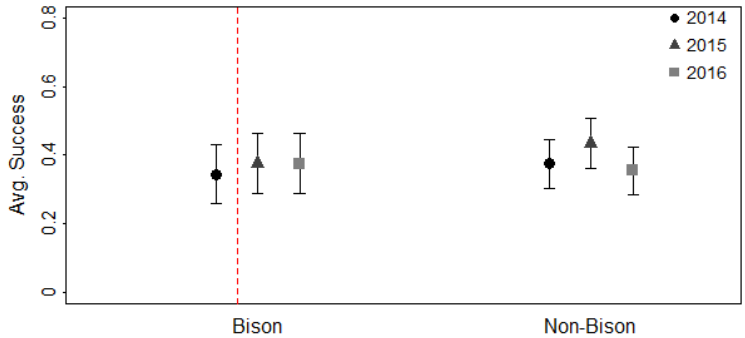
Mean nest success ± 1SEM in the bison and non-bison tracts by year. b) Mean nest density ± 1SEM in the bison and non-bison tracts by year. c) Mean proportion of nests parasitized ± 1SEM in the bison and non-bison tracts by year. Red dotted line on all graphs denotes when and where bison were reintroduced.

Artificial Nest Study

Out of the 80 deployed nests, 36% of them were successful, which is a decrease from last year. A nest is scored as survived if there is no predation on at least one clay egg; quail eggs were not used to determine success. The number of nests deployed per planting varied by the size and shape of the planting; however, each planting pair had a similar total number of nests deployed. Average success was similar across years and between the bison and non-bison sites (Figure 2).

Variation in the success is less with artificial than with the natural nests, suggesting that density or species may play a role in the variation seen. Overall, average success was statistically different between planting ages (F=10.012,77; p<0.001), where younger plantings had lower success than old or remnant sites. Like natural nests, burn frequency changed this year compared to the other two years, but nest success was correlated with fire return interval (t=2.35, df=78, p=0.022), where success was higher with longer fire return intervals. The species of predators that preyed on these eggs was determined by the bite mark impressions on the clay eggs. There was one trap camera placed per site and they did not consistently give good pictures and were

only used to verify results or shed light on missing nests. The cameras were able to document other nest visitors not represented by the clay eggs. *Peromyscus* spp. and *Ictidomys tridecemlineatus* were the top predators of these eggs. Bison were not caught on camera this year; however last year when they were caught on camera, they did not trample or depredate any nests. When the nest was depredated, the average success was lower and varied between predator. Bite number ranged from one to over twenty, but most nests had less than ten bites. The eggs with the fewest bites did not necessarily have higher average success.



Mean artificial nest success ± 1SEM in the bison and non-bison tracts by year. Red dotted line on all graphs denotes when and where bison were reintroduced.

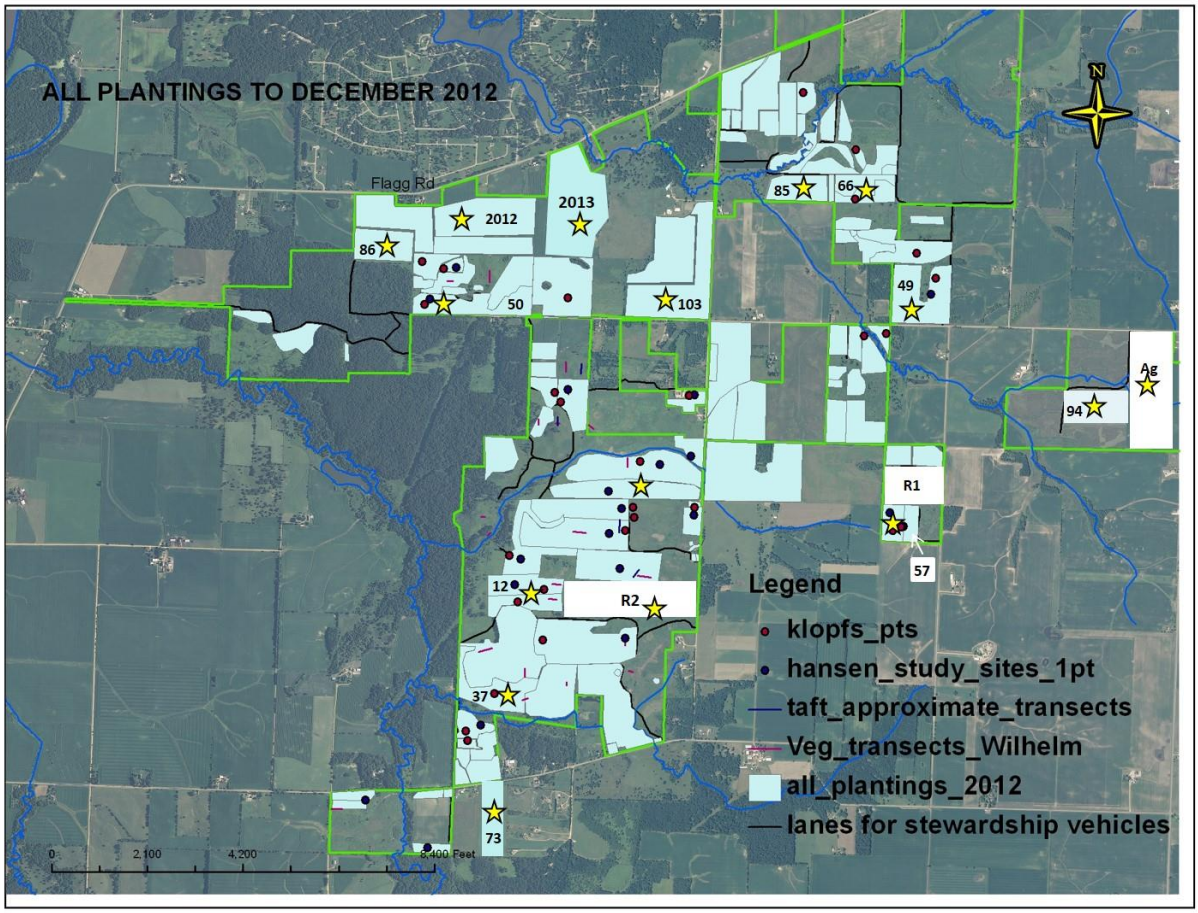
Species Composition

Sound files from each site are currently being processed. Some sites have more calls than others and this can be from the position of the recorder in the site as well as the number of artificial perches near the recorder. In the future, the experimental design will be re-worked to limit the number of artificial perches. This means moving the recorders outside of the bison-free zones, which could increase their chances of damage.

Heather Herakovich, Northern Illinois University

Evaluating Dung Beetle and Soil Microbial Communities in Restored Tallgrass Prairies Following Bison Reintroduction

As part of a continuing multi-investigator research program examining the re-establishment of trophic interactions following tallgrass prairie restoration, this project studied the community re-establishment of dung beetles and soil microbes (Bacteria, Archaea, and Fungi) following prairie restoration and bison reintroduction. Ground beetle sampling took place at sites throughout Nachusa Grasslands (see map) between 30 May - 6 June, 28 June – 5 July, and 16 - 18 September. Sampling was in the same sites marked with stars on the map. Dung beetle sampling took place on 19 - 26 May, 8 - 15 June, and 24 - 31 August at sites marked with circles on the map. Soil collection took place monthly from April through October in all plantings included in the ground beetle surveys, as well as a soybean field near the Thelma Carpenter Prairie.



Map of beetle trapping sites and soil collection sites

Ground beetle sampling collected approximately 690 beetles of at least 5 species (number of specimens in parentheses): *Onthophagus Hecate* (409), *Aphodius* spp. (9), *O. knausi* (265), *Copris minututs* (2), and *Geotrupes opacus* (1). Identifications were completed by a NIU undergraduate in November 2016. We are currently examining patterns of abundance and community composition of dung beetles I relation to restored prairie age, bison presence, and time since last fire.

DNA extractions from soil samples have been partly carried out. When completed, they will be sequenced and added to a growing dataset across several years to document how bacterial communities in soil change following prairie restoration from an agricultural field.

Nicholas A. Barber, Northern Illinois University

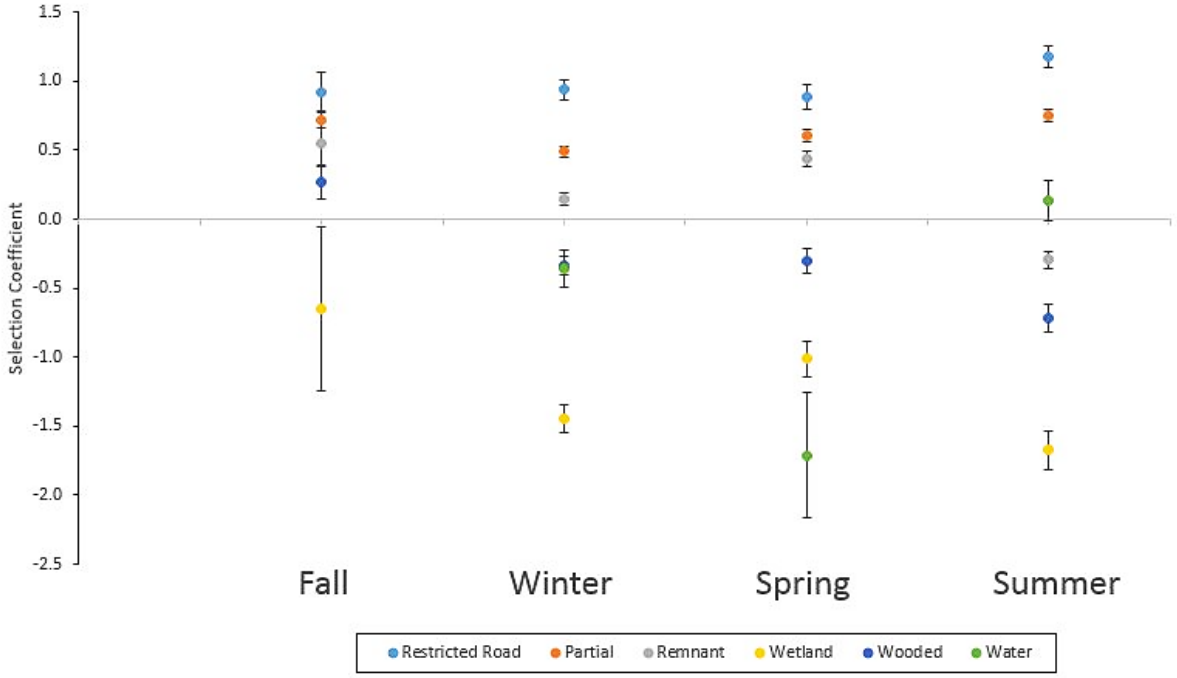
Habitat Selection of Reintroduced Bison at Nachusa Grasslands

During the two-year study period of bison habitat selection (November 2014-August 2015), we collected 112,166 hourly bison locations. Each of these used locations was paired with 10 random available locations and GIS data was extracted at each location. We compared locations

the bison used to all available locations to quantify the influence of landcover and fire management on habitat use by season. Landcover types included fully restored prairie, partially restored prairie, remnant prairie, restricted roads, wetlands, wooded areas, and water. Fire management variables included the number of burns since 2004 and whether an area had been burned recently (i.e., in the past 6 months).

Selection for each landcover type was evaluated relative to fully restored prairies (see figure below). Bison had higher selection for partially restored prairie and restricted roads and weaker selection for wetlands in every season. Relative selection for remnant prairie, wooded areas, and water varied seasonally. Bison had stronger selection for remnant prairie in the fall, winter, and spring, and weaker selection in the summer; stronger selection for wooded areas in the fall and weaker selection in the winter, spring, and summer; and stronger selection for water in the summer and weaker selection in the winter and spring. Water was not an available landcover type in the fall.

Fire management also affected bison habitat selection by season. Selection for an area increased with the number of burns since 2004 in the winter and spring and decreased in the fall and summer as the number of past burns increased. During the study period, no fall season burns occurred in the bison units. As a result, recently burned areas were only available in the spring and summer. During these seasons, bison also selected for the recently burned areas.
Our next step is to map bison habitat use. By adjusting input data regarding management, we can visualize how management activities could affect bison use throughout the preserve. This information can inform future management decisions regarding burn regimes.



Landcover selection by season. Selection of each landcover type is relative to fully restored prairie (the zero-line). Landcover types above the zero-line indicate relatively stronger selection; landcover types below the zero-line indicate relatively weaker selection.

Prairie Bush Clover (*Lespedeza leptostachya*) Population Viability at Nachusa Grasslands

Prairie bush clover (PBC), *Lespedeza leptostachya*, is a federally threatened species found only on gravel hilltops and knobs in a narrow portion of the tallgrass prairie. It enjoys its largest presence in the southern most portion of the range at Nachusa Grasslands. Understanding the habitat currently inhabited by PBC at the Nachusa Grasslands, and establishing characteristics of that habitat that are correlated with population performance is important to determining the best sites to establish new populations. In addition, understanding patterns in seed germination will help determine how and when to use seeds to introduce PBC to new sites, as well as inform the management of these new populations in terms of prescribed burn intervals and the timing of new plantings.

Reintroduction Case Study

The Nature Conservancy has demonstrated the effectiveness of sourcing seed from within the site for restoration (local translocation) at Nachusa Grasslands. Generally limiting seed use for prairie restoration to those species located in prairie remnants on the preserve or otherwise very local sources has led to very high quality sites across the preserve. Using a similar philosophy, an experimental reintroduction of Prairie bush clover, *Lespedeza leptostachya,* is underway. We undertook a small-scale study to determine the best locations to introduce new *L. leptostachya* populations within the preserve. Seeking to characterize the habitat at Nachusa Grasslands that is currently inhabited by *L. leptostachya*, and establishing those parameters correlated with population performance was tested to determine if we could increase the success of those introductions, by increasing plant survivorship, plant reproductive output and/or offspring recruitment at the new sites.

Six sites were surveyed in 2014 to better understand the overall habitat occupied by this species. We characterized each of the six sites based upon the size of the Prairie Bush Clover population as small, medium or large depending upon the standing census size (>15, >35 and >120 plants), and analyzed the combined data. Overall, this approach showed that plots within the same site are more similar to each other than to plots in other sites, basically revealing that the vegetation and soil at each site are somewhat distinct from each other. However, the size of the populations across the sites appears to be influenced by two key environmental factors: the percentage of sand in the soil, and the estimated litter cover of the plots. Sand content was negatively correlated with population size, which suggests that prairie bush clover, while tolerating a very high sand content (~85%), prefers a lower sand content (~ 72%).

In early June of 2015 we undertook an analysis of the preserve, to identify areas similar to those currently supporting *L. leptostachya* populations. Using GIS, which included a LiDAR layer, we visually identified areas with similar slope and aspect within the boundaries of the Nachusa Grasslands, and then ground-truthed each to determine if the community structure and basic habitat were similar. Image classification, Species Distribution Modeling, or other methods employed to more objectively assess habitat matches were unsuccessful due the very small patches of habitat occupied by *L. leptostachya*. We also assessed the sand content of the soil of

each site. Two sites were considered appropriate, which included a site planted by the Nature Conservancy staff and volunteers (the one we considered the "best" match to current sites), as well as seven other newly restored areas. They planted 25 individuals in each area, and we assessed within season survivorship at each site in October 2015.

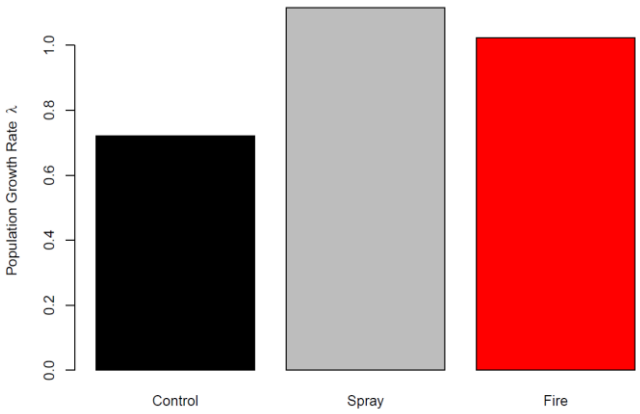
A follow-up survey was conducted in September 2016. Overall survivorship across the eight plantings was 31% and ranged from 4% to 40% at the recently restored sites. A few individuals produced small amounts of seed (<50), but many of the plants failed to thrive, and lost significant above-ground biomass, experiencing a decline in size. Survivorship at the best matching site was very high, 80%, and supported large plants, bearing high seed loads (>350). Continued monitoring of these plantings will determine if seedlings are able to establish and survive, indicating the potential for the site to support a viable population of this species.

Ongoing Research Activities

In 2016, all permanent plots were censused and demographic data as well as vegetation data were collected. Management Area 1 contained 271 plants, Management Area 2 contained 73 plants, and Management Area 3 contained 84 plants.

The project research team leads, consisting of Drs. Tiffany Knight, Mickey Schuztenhofer and Pati Vitt, finalized models of population growth using an Integral Projection Model approach. We undertook a multi-year demographic study to evaluate how grazing (or simulated grazing via the application of grass-specific herbicide) interacts with other management practices, prescribed fire in particular, to fully understand their effects on plant population growth. We focused on the following objectives/questions: Does reduction of grass cover/height via simulated grazing (application of grass-specific herbicide) increase population growth rates of *L. leptostachya*? Does fire increase or decrease population growth rates (lambda) of *L. leptostachya*? In addition to building a population projection model, we undertook a Life Table Analysis to determine which life history stages are most affected by management activities.

We projected population growth rates for natural conditions without fire or simulated grazing, and found that growth is significantly <1 under natural conditions, providing evidence that the population will generally shrink without ongoing management such as grazing or fire (see figure). The application of grass-specific herbicide, which significantly reduced grass height and cover thereby reducing competition, had the greatest positive effect on the population growth rate, resulting in a projected significantly >1. This leads us to expect that the population will respond positively to



Projected population growth rates for Lespedeza leptostachya under natural conditions without fire or simulated grazing (bars in black); simulated grazing via the application of Poast grass-specific herbicide (bars in gray); and following a spring burn (bars in red).

grazing by large herbivores such as bison. In addition, the projected population growth rate after a spring burn is also significantly increased, very close to 1, resulting in a stable population size over time when burning is a consistent management activity.

We subsequently performed a life table analysis to determine which life history stages had the greatest contribution to the differences in the population growth rates under controlled versus treated (i.e.: simulated grazing and fire) conditions. For both fire and grazing, seedling recruitment has a very significant contribution to the population growth rate, as does the average growth rate of all individuals in the study plots. The effects of fire are a bit more complex, however, as survival also has a significant positive effect on the population growth rate. Fire also appears to decrease the importance of flowering, which might be a tradeoff to survival.

Overall, management activities undertaken by the Nachusa Grasslands staff appear to have a significant benefit on the population viability of *L. leptostachya*. Although this current study only addresses simulated grazing via the experimental application a grass-specific herbicide, the *Lespedeza* project team will continue data collection through at least the summer of 2018, at which point we will incorporate bison grazing into our modeling effects to determine if this has the predicted effect of increasing the viability of this species. We will submit these results for publication in a peer-reviewed journal by the end 2017.

Pati Vitt, Chicago Botanic Garden

Preliminary Inventory of Earthworms of the Nachusa Grasslands Area

Eight species of earthworms, all in the family *Lumbricidae*, were collected from 23 Nachusa Grasslands sites between April 21 and October 7, 2016 (4 sites in April, and 19 sites in October). Of these species, one – *Bimastos welchi* (Smith, 1917)—represents a new state record. Two species – *Dendrodrilus rubidus* and *Eisenia foetida* – previously reported from Lee County, were not collected during this study. Six species – *Diplocardia communis* (Family *Acanthodrilidae*), *Bimastos parvus*, *Dendrobaena octaedra*, *Eiseniella tetraedra* (Family *Lumbricidae*), and *Sparganophilus eiseni* (Family *Sparganophilidae*) –previously reported from one or more counties adjacent to Lee and Ogle Counties, were not collected during this study. One species reported by Wodika *et al*. in 2014 – *Bimastos longicinctus* (Smith & Gittens, 1915)—was not collected from any of our 23 sites at Nachusa Grasslands during 2016, although it had previously been reported from nine other counties in Illinois – all of which are south of Lee County.

Several species collected during this study represent new county records for Lee County (*Aporrectodea rosea* and *Octolasion tyrtaeum*), and Ogle County (*Aporrectodea tuberculata*, *Aporrectodea tuberculata*, *Lumbricus terrestris*, and *Octolasion tyrtaeum*).

Mark J. Wetzel, Illinois Natural History Survey

Small Mammal Research at Nachusa Grasslands

This was the fourth year of mammal trapping and the goal was to get a sense for the diversity and abundance of small mammals along the chronosequence of study sites and with differential prescribed burning and grazing influence and with/without bison. We caught 242 animals over four trapping sessions, recaptured already tagged animals 186 times, and caught a total of eight species.

Major findings were:
1. Forbs decrease and grass increases with time since restoration in our site.
2. Small mammal diversity increases with restoration age.
3. Small mammals decrease in abundance and diversity with bison grazing.
4. Small mammals increase in abundance and diversity after burn.

Holly Jones and Angela Burke, Northern Illinois University

Bird-provisioned Pest Removal Services on Conventional Farms: An Evaluation of an Ecosystem Services Approach as a Tool for Prairie Bird Conservation

I collected 124 fecal samples from birds captured in both prairie and adjacent cropland habitat between 1 June and 8 October, 2016. All birds were captured in mist nets, banded, and released on site. The table below shows a list of species captured and the number banded.

Common Name	Scientific Name	Number Banded
Brown thrasher	*Toxostoma rufum*	1
Cedar waxwing	*Bombycilla cedrorum*	1
Downy woodpecker	*Picoides pubescens*	1
Eastern meadowlark	*Sturnella magna*	1
Eastern towhee	*Pipilo erythrophthalmus*	1
Red-headed woodpecker	*Melanerpes erythrocephalus*	1
Northern (yellow-shafted) flicker	*Colaptes auratus*	1
Eastern kingbird	*Tyrannus tyrannus*	2
Savannah sparrow	*Passerculus sandwichensis*	2
Brown-headed cowbird	*Molothrus ater*	3
Indigo bunting	*Passerina cyanea*	3
Red-winged blackbird	*Agelaius phoeniceus*	3
Willow flycatcher	*Empidonax traillii*	3
American robin	*Turdus migratorius*	6
American goldfinch	*Spinus tristis*	8
Field sparrow	*Spizella pusilla*	9
House wren	*Troglodytes aedon*	10
Dickcissel	*Spiza americana*	13
Grey catbird	*Dumetella carolinensis*	15
Song sparrow	*Melospiza melodia*	21
Common yellowthroat	*Geothlypis trichas*	27
Total:	**21 Species**	**132 new bands**

Over the last few months, I have been working with collaborators to extract arthropod DNA from

those fecal samples in order to determine what arthropods the birds had been eating. I have just received that DNA sequencing data, and will be analyzing it over the course of the next few months.

Arthropods were collected from corn and soy plants (on fields leased to farmers by Nachusa Grasslands) on 24 September, 1 October, and 8 October, 2016. Arthropods were collected using an insect vacuum, and placed in 90% ethanol.

I collected 36 samples, and each contains approximately 0-5 arthropods. I used bird exclosures (cages placed over crops that keep birds out) in corn and soy fields adjacent to prairie to look for indirect effects of birds on crop yield. I placed six exclosures in a soy field, and six exclosures in each of two corn fields, for a total of 18 exclosures. Birds can either provide services by eating crop-damaging pest arthropods, or they can provide disservices by eating "beneficial" arthropods. In October 2016, I harvested corn ears and soybean pods inside exclosures and in nearby control plots. I am currently still drying out the crop samples to a consistent level, so that I can compare the weight and volume of crops inside and outside of the exclosures.

Megan Garfinkel, University of Illinois at Chicago

Comparing Bison and Cattle Parasites at Nachusa Grasslands

Eight bison and eight cow samples were processed because there was not enough lab time for undergraduate Jess Fliginger to do more. The samples were separated by season – four from the winter and four from the spring. Jess identified 77 bison and 76 cow parasites of three distinct helminth species in bison and cattle herds located within and around Nachusa Grasslands. The largest and most prevalent helminth species were *Ascaris* spp. and *Strongyle* spp. while *Strongyloide* spp. were smaller and less abundant. Although *Tricuris* spp. were detected in one bison sample and *Paramphistomum* spp. were detected in one cow sample, these results were not significant. Overall, the results of this study show that bison helminth parasites are significantly larger in diameter and width than cattle parasites. Jess did observe a seasonal shift from winter to spring with a higher number of parasites per individual in the spring. After comparing my results to the inoculation records of the bison from Fall 2015, Jess found that they only looked for *Moneiza* and *Strongyle* parasites. Jess was unable to find any *Moneiza* spp.; however, this may be because they are only found by using the flotation technique, which we didn't use. Most bison parasites were *Strongyles* and, similar to the inoculation results, the presence of this parasite in each host was extremely variable. About 43 percent of the parasites found in cattle were *Ascaris*. spp. compared to 10 percent in bison, suggesting that contact between species could influence the number of *Ascaris* spp. found.

Holly Jones, Northern Illinois University

Dragonfly and Damselfly Monitoring at Nachusa Grasslands

Dragonflies and Damselflies were surveyed at Nachusa Grasslands on multiple dates between 24 April and 24 September, 2016. Temperature and wind speed data were collected as well as a count of the number of each species recorded. Researchers missed the migration massing this season, which impacted the normally large green darner/black saddlebag numbers. Additionally, researchers failed to count any American rubyspots (*Hetaerina Americana*) at Clear Creek this season. This could just be a monitoring miss, but it is unusual to not see them.

New Species in 2016:

- Dragonflies– Wandering glider (*Pantala flavescens*), prince baskettail (*Epicordulia princeps*), shadow darner (*Aeshna umbrosa*)

Species recorded at Nachusa previously which were missing in 2016:

- Dragonflies: Midland clubtail (*Gomphus fraternus*), band-winged meadowhawk (*Sympetrum semicinctum)*, Carolina saddlebags (*Tramea carolina*), slaty skimmer (*Libellula incesta*)
- Damselflies: American rubyspot (*Hetaerina americana*), springwater dancer (*Argia plana*), violet dancer (*Argia fumipennis violacea*); eastern red damsel (*Amphiagrion saucium*)

Total number of identified species in 2016**:** 18

- Dragonflies: 14 species
- Damselflies: 4 species

Total number of dragonflies and damselflies in 2016

- Dragonflies: 236
- Damselflies: 55

Cindy Crosby and Bill Kruk

Inventory of *Carex* spp. at Nachusa Grasslands

Botanists searched Nachusa Grasslands for *Carex* spp. the week of 16 June, 2016 and again the week of 17 July, 2016. Culms with seed heads were photographed in the field with a GPS camera and then collected for later macro- and micro-images.

The Nachusa Grasslands herbarium contained 42 *Carex* spp. 20 are county records based on State herbaria ILLS and ISM for Lee County. About half the species in the Nachusa Grassland herbarium were found in this field research, which also added five new species to the plant inventory. Unidentifiable species are checked against nearby prairie states' herbaria.

Linda W. Curtis

Health Assessment of Ornate Box Turtles at Nachusa Grasslands

From 6 – 8 May, 2016, human and canine search teams located 72 live and three deceased ornate box turtles within the Orland Tract of Nachusa Grasslands. All live animals were released at the site of capture within 4 hours. The shells (or pieces of shells) were returned to the University of Illinois for infectious disease testing. Health assessments were performed for each live turtle including physical examination, hematology, plasma biochemistry, blood gas panels, protein electrophoresis, and qPCR infectious disease screening of cloacal/oral swabs and whole blood samples. Health parameters and disease presence will be evaluated for spatial trends.

Matt Allender, University of Illinois at Urbana-Champaign

Long-Term Stream Monitoring to Assess the Effects of Prairie Management on Streams

Nachusa Grasslands has some unique aquatic features including a spring-sand boil, seep/fen area and one of very few cold-water streams found in Illinois, Wade Creek. Since Wade Creek has several unique and high quality aquatic features, long-term monitoring was established to assess baseline stream conditions before bison reintroduction and systematic sampling protocols were initiated for long-term stream monitoring of prairie land management practices.

In 2013, four temperature loggers were placed in Wade Creek, Wade Creek Z-crossing, Johnny Creek, and Clear Creek to record stream temperature every 15 minutes. Temperature loggers were downloaded biannually in the spring and fall. Stream temperature was categorized as cold water (< 19 °C), cool water (19 – 23.7 °C), and warm water (> 23.7 °C) based on mean daily July temperature. Wade Creek and Clear Creek were classified as cold water streams with temperatures of 15.6 °C and 17.5 °C, respectively. Johnny Creek was classified as a cool water stream with a temperature of 20.2 °C. Wade Creek Z-crossing shifted from a cold-water stream (15.2 °C) in 2013-2015 to a cool water stream (23.1 °C) in 2016 (see figure below).

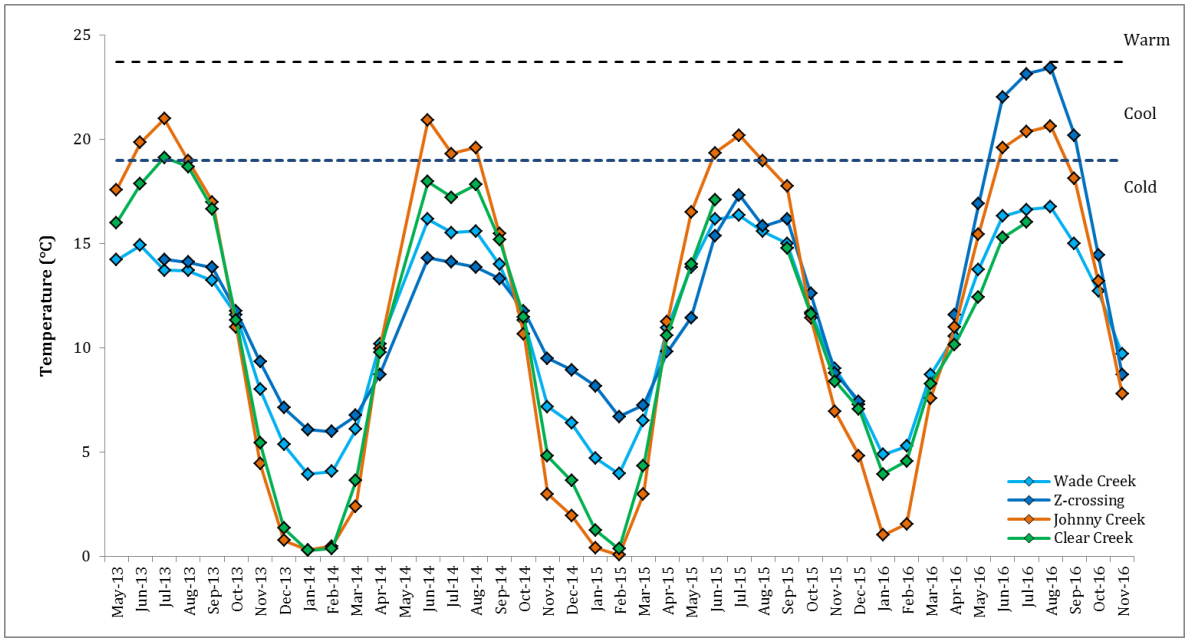


Figure 2: Stream temperature profiles at four sites at Nachusa Grasslands. Stream temperature categories (cold, cool, and warm water) are indicated by dashed lines.

In Fall 2014, three water level loggers and one barometric logger were installed at three locations in Wade Creek to monitor the amount of water entering and leaving Nachusa. The water level loggers hang within a PVC pipe submerged in stream to record water pressure and the barometric logger hangs above the stream to record atmospheric pressure. PVC pipe has holes drilled approximately one inch apart along the pipe to allow stream water to flow through. Discharge was measured monthly, or at multiple water levels, at each water level logger location to calibrate water level to stream discharge. Data loggers were set to record every 15 minutes for

continuous stream monitoring, and downloaded biannually in the spring and fall. Fen footbridge had an annual discharge of 0.04 meters^3/second. Water level loggers at Lowden Road and Z-crossing did not have enough data to calibrate discharge due to drying or buried loggers.

To establish the baseline conditions of Wade Creek, macroinvertebrates were surveyed using Environmental Protection Agency protocols before bison were reintroduced. Two reaches (TNC habitat assessment Transect 3 and TNC habitat assessment Transect 7) of Wade Creek were surveyed in July 2013, April 2014, and July 2015. Only Transect 7 reach was surveyed in May 2016 because bison were grouped with calves near Transect 3 reach. At this time, three bioassessments have been processed and analyzed for multiple metrics (see table below). Wade Creek taxa richness ranged from 10 – 17 genera across samples. *Ephemeroptera*, *Plecoptera*, and *Trichoptera* species comprised a small portion of the samples with only one *Ephemeroptera* (mayfly; *Baetis*) and three *Trichoptera* (caddisfly; *Hydropsyche*, *Chematopsyche*, and *Neophylax*) genera identified. All samples were dominated by intolerant *Gammarus* species ranging from 70% – 91.1% of the individuals in the sample which is reinforced in the low Shannon-Wiener Index that ranged from 0.49 – 1.22 indicating that Wade Creek has low evenness. Conversely, Hilsenhoff Biotic Index rankings ranged from excellent (3.23-3.47) to very good (3.72) across all samples.

	Transect 3		Transect 7
Metric	July 2013	April 2014	July 2013
Hilsenhoff Biotic Index	3.72	3.23	3.47
IEPA Macroinvertebrate IBI	25.18	21.85	29.91
Shannon-Wiener Index	1.22	0.49	1.01
Total Richness	11	10	17
EPT Richness	3	2	2
Ephemeroptera Richness	1	0	1
Coleoptera Richness	1	1	2
Intolerant Richness	2	1	2
% EPT	5.2%	1.6%	4.5%
% Scraper taxa	7.0%	2.8%	10.1%
% Intolerant taxa	70.4%	91.1%	81.7%
% Tolerant taxa	29.6%	8.9%	18.3%
% Dominant taxa	70.0%	91.1%	79.2%

Multiple metrics describing macroinvertebrate communities at two reaches in Wade Creek.

A target fish survey was conducted with Phil Willink of the Shedd Aquarium in April 2015 using a backpack shocker at base flow to confirm the presence of coolwater obligate Brook Stickleback (*Culaea inconstans*) and Threatened American Brook Lamprey (*Lethenteron appendix*). Brook Stickleback and American Brook Lamprey presence was confirmed during the survey. Other species sampled during the survey included Central Mudminnow (*Umbra limi*), Central Stoneroller (*Campostoma anomalum*), Creek Chub (*Semotilus atromaculatus*), Common Shiner (*Luxilus cornutus*), Fathead Minnow (*Pimephales promelas*), Green Sunfish (*Lepomis*

cyanellus), White Sucker (*Catostomus commersonii*), Blacknose Dace (*Rhinichthys atratulus*), and Johnny Darter (*Etheostoma nigrum*).

Wade Creek structure and function will be assessed by sampling habitat, water quality, macroinvertebrates, and fish after bison are reintroduced following same sample methods for establishing baseline stream conditions. Additionally, water samples (dissolved oxygen, nutrients, and suspended solids) will be collected before, during, and after prescribed burning along Wade Creek to assess effects of common prairie land management.

Jodi Vandermyde, Illinois Natural History Survey

Other Research Projects by Staff or Supported by The Nature Conservancy in Illinois

FIRE RESEARCH & DEMONSTRATION PLOTS

The purpose of this study is to demonstrate and study the effects of different prescribed fire frequencies and seasonality on the structure, composition and successional trajectory of tallgrass prairies. Modeled after the Hulbert fire demonstration plots at Konza Prairie Biological Station, KS, our intent is to replicate a similar experiment locations that are publicly accessible, initially at the Nachusa Grasslands Preserve visitor use area to be developed in 2016. The study uses a randomized block design to apply three replicates of five fire treatments: annual dormant season fire, biennial dormant season fire, 4-year dormant season fire, 4-year growing season fire, and unburned (15 total plots). Plots are 10m X 25m, labeled with its fire treatment, and have generally uniform ecological conditions and composition in a restored prairie. The Nachusa site, and other places where the demonstration could be replicated, should be in restored (not remnant) locations since the unburned treatment (unburned) is expected to lead to substantial degradation of plots during the experiment, which we expect to last a minimum of 14 years (3 cycles of all treatments). During the study, other customary stewardship will continue (suppression of non-native invasive species), but native species should not be suppressed. Vegetation transects will be sampled in each plot at Year 1, Year 6, and Year 14.

Jeff Walk, Bill Kleiman, Cody Considine, The Nature Conservancy

USE OF COVER CROP FIELDS BY MIGRATORY AND RESIDENT BIRDS IN THE MIDWEST

Cover crops have become increasingly popular in the Midwest to improve soil and water quality, however the impact on migratory and resident birds is largely unknown. We conducted avian surveys in corn and soy field with and without cover crops in east central Illinois in the spring of 2015 and 2016. For each field type, we calculated bird density and the Avian Conservation Significance value (ACS). Bird density was greater in cover crop fields than non-cover crop fields, with the corn fields planted with cover crops providing the greatest value (nearly twice the number of individuals and twice the species compared with non-cover crop soybean fields). The most common species were Red-winged Blackbird (*Agelaius phoeniceus*), Common Grackle (*Quiscalus quiscula*), and American Robin (*Turdus migratorius*). ACS values were most influenced by the Eastern Meadowlark (*Sturnella magna*), a species of high conservation concern. Many agricultural landscapes lack habitat in the spring and cover crop fields may be important areas to provide shelter and forage for birds. Cover crops will not replace natural habitats for birds, but the widespread use of cover crops may benefit some bird populations.

Cassandra Wilcoxen and Mike Ward, University of Illinois

THE CONSERVATION VALUE OF THREE AGRICULTURAL PRODUCTION SYSTEMS FOR BIRDS AND POLLINATORS

This agricultural biodiversity project stems from the Franklin Research and Demonstration Farm Project, located in Lexington, IL. To evaluate the Franklin Farm's goal of restoring woodland, savanna, prairie and wetland habitats to increases the biodiversity of plants and animals within an agricultural landscape, bird and pollinator surveys were conducted across three farm production systems in the spring and summer of 2015 and 2016. Bird surveys consisted of walking transects in cover crop fields in the spring and point counts in the summer. Pollinator surveys consisted of insect traps to target bees and walking transects to count butterflies in the summer. The three farm production systems were conventional, conservation, and organic. For the scope of this project, a conservation farm is defined as having three or more conservation practices utilized on the field at any time within the planting/growing season. All organic farms included in the study are certified organic through USDA accredited certification agencies.

Preliminary analysis of suggests that conservation farm production systems support more diverse and abundant communities of birds and bees than conventional and organic farm production systems. Overall, the butterfly community is depauperate. The additional structure provided by previous year crop stubble and cover crops in the no-till conditions of conservation farms may provide more attractive habitat for birds and bees (many of which are ground nesting), compared to conventional and organic farms that utilize tillage.

Cassandra Wilcoxen, University of Illinois at Urbana–Champaign

CONSERVING NATURE'S STAGE

Climate change is creating an increasingly dynamic natural world by shifting species distributions and rearranging habitats. Consequently, conservationists need a way to identify important areas for protection that does not assume that the locations of existing plants and animals will stay the same. Rather than trying to protect diversity one species at a time, the key is to protect the different "stages" upon which the drama of nature unfolds. These stages are based strongly on geology and consist of recognizable geophysical settings such as coastal sands, limestone valleys, granite summits, or silt floodplains, that each support a distinct set of species. Conserving a range of physical environments offers an approach to conservation that protects a diversity of plants and animals under both current and future climates.

The number of plants and animals in each state is correlated with the number of geology types, the amount of limestone, the latitude, and range of elevation in the state. These geophysical factors form ecological regions across the landscape that support different species. Natural strongholds are places where the direct effects of climate change are moderated by complex topography and connected natural cover, and where the current landscape contains high quality biodiversity features. Natural strongholds can serve as a bridge to grant safe passage into the future for thousands of species. In these sites, species can find areas of suitable moisture and temperature within their local neighborhood. This allows resident species populations to remain strong and helps ensure that changes in the composition and structure of the communities will be more gradual.

With a changing climate, many places may become degraded and lose species, but some places will retain high quality habitat and continue to support a diverse array of plants and animals. Sites that have both complex topography and connected land cover are places where conservation action is most likely to succeed in the long term. Permanent conservation of the resilient areas should be prioritized to ensure they can continue to provide habitat for species. This analytical process was pioneered in the northeastern US and successfully applied to the southeastern region, and mountain northwest. Thanks to a grant from the Doris Duke Charitable Foundation, this analytical process expanded to the Great Lakes and Great Plains ecoregions in 2015, with completion expected in 2017. Representatives from TNC chapters in the region and external partners are serving on a steering committee to help adapt the methodology to the unique settings of each ecoregion.

Mark Anderson, Kim Hall, and Meredith Cornett, The Nature Conservancy

Professional Publications

*(The Nature Conservancy staff and projects in **bold**)*

Dungey K. E., M. J. Lemke. 2016. "Mike and Keenan's Excellent **Emiquon** Adventure," In: K. Vaidya, editor. Chemistry for the Curious. The Curious Academic Publishing Co., Canberra (AU)

Griffin, S.R., B. Bruninga-Socolar, M. Kerr, J. Gibbs, & R. Winfree. 2017. Wild bee community change over a 26 year chronosequence of restored tallgrass prairie. *Restoration Ecology*.

Hagy, H. M., C. S. Hine, M. M. Horath, A. P. Yetter, R. V. Smith, and J. D. Stafford. 2016. Waterbirds as indicators of floodplain wetland restoration. Hydrobiologia DOI: 10.1007/s10750-016-3004-3.

Hagy, H. M., C. S. Hine, M. M. Horath, A. P. Yetter, R. V. Smith, and J. D. Stafford. 2016. Waterbirds as indicators of floodplain wetland restoration. Hydrobiologia DOI: 10.1007/s10750-016-3004-3.

Hagy, H. M., M. M. Horath, A. P. Yetter, R. V. Smith, and C. S. Hine. 2016. Evaluating tradeoffs between sanctuary for migrating waterbirds and recreational opportunities in a restored wetland complex. Hydrobiologia DOI: 10.1007/s10750-016-2711-0.

Hagy, H. M., C. S. Hine, M. M. Horath, A. P. Yetter, R. V. Smith and J. D. Stafford. 2016. Waterbird response indicates floodplain wetlands restoration. Hydrobiologia. doi:10.1007/210750-016-3004-3.

Hagy, H. M., M. M. Horath, A. P. Yetter, C. S. Hine and R. V. Smith. 2016. Evaluating tradeoffs between sanctuary for migrating waterbirds and recreational opportunities in a restored wetland complex. Hydrobiologia. doi:10.1007/s10750-016-2711-0.

Hine, C. S., H. M. Hagy, M. M. Horath, A. P. Yetter, R. V. Smith, and J. D. Stafford. 2016. Response of vegetation to floodplain wetland restoration in the Illinois River valley. Hydrobiologia DOI: 10.10007/s10750-016-2893-5.

Lemke, M. J., H. M. Hagy, A. F. Casper, H. Chen. Accepted; in revision. Chapter 5. Floodplain and Wetland Shallow Lake Restoration in the Midwest. In: Lenhart, C. and P. C. Smiley Jr. (eds). Ecological Restoration in the Midwest: Building on the Legacy.

Lemke, M. J., H. M. Hagy, K. E. Dungey, A. F. Casper, **A. M. Lemke**, T. D. VanMiddlesworth and A. Kent. In Press. Echoes of a flood pulse: Short-term effects of record flooding of the Illinois River on floodplain lakes under restoration. Hydrobiologia.

Sparks, R. E., **K. D. Blodgett**, A. F. Casper, H. M. Hagy, M. J. Lemke, L. R. M. Velho and L. C. Rodrigues. 2016. Why experiment with success? Opportunities and risks in applying assessment and adaptive management to the **Emiquon** floodplain restoration project. Hydrobiologia. doi:10.1007/s10750-016-2785-8.

VanMiddlesworth, T. D., N. N. McClelland, G. G. Sass, A. F. Casper, T. W. Spier and M. J. Lemke. 2016. Fish community succession and biomanipulation to control two common aquatic ecosystem stressors during large-scale floodplain restoration. Hydrobiologia. doi:10.1007/s10750-016-2696-8.

VanMiddlesworth T. D., G. G. Sass, B. A. Ray, T. W. Spier, J. Lyons, N. N. McClelland, A. F. Casper. 2016. Food habits and relative abundances of bowfin, spotted gar, and largemouth bass: Implications for controlling common carp. Hydrobiologia River Floodplain Restoration Special Issue, Online: 29 July 2016: 1 – 13). DOI: 10.1007/s10750-016-2866-8.

Research Reports and Popular Publications

Hagen, S., A. Cisneros, K. Kirkham, S. McClure, and **J. Walk**. 2016. 2015 Science Report. The Nature Conservancy in Illinois. 82 pages.

Hagy, H. M., S. E. McClain, J. W. Simpson, J. M. Osborn, and A. P. Yetter. 2016. True Metabolizable Energy of Submersed Aquatic Vegetation in Semi-Permanent Marshes for Dabbling Ducks in the Upper Midwest. Annual Performance Report (FY16). INHS Technical Report 2016(40).

Hagy, H. M., A.P. Yetter, J. M. Osborn, M. M. Horath, C. S. Hine, D. R. McClain, K. M. Walter, A. D. Gilbert, T. J. Benson, J. M. Fox, and M. P. Ward. 2015. Illinois Waterfowl Surveys and Investigations W-43-R-62. Annual Progress Report. INHS Technical Report 2015 (39).

Hilsabeck, R. 2015. IDNR **Emiquon** Status Report 2015. Illinois Department of Natural Resources.

Hine, C. S., H. M. Hagy, A. P. Yetter, M. M. Horath and J. M. Osborn. 2016. Waterbird and wetland monitoring at the **Emiquon Preserve**. Final Report 2007–2015. INHS Technical Report 2016 (26). 80 pp.

Lemke, A. M., 2016. Evaluating the ecological and cost effectiveness of constructed wetlands at reducing nutrient export in tile-drained subwatersheds of the **Mackinaw River**, Illinois. Final report: Monitoring effectiveness of CP39 wetlands. Submitted to USDA-Farm Services Agency. 31 July 2016.

King, R. B. Animal Responses to Prairie Restoration at **Nachusa Grasslands**. 2016. Annual Research Report. 35 pp.

Kirkham, K. G., A. R. Maybanks, D. A Kovacic, M. P. Wallace, and **A. M. Lemke**. 2016. 2015 **Franklin Research and Demonstration Farm** Report. Annual report.

Ohler, A. 2016. TNC Economic Report for Conservation Practices. Illinois State University. Final Report. November 2016.

Walk, J.W., K.S. Baker, R.E. Sparks. 2016. Data stewardship workshop report. The Nature Conservancy and University of Illinois. http://hdl.handle.net/2142/94785

Wetzel, M. J. and J. W. Reynolds. 2016. A Preliminary Inventory of Earthworms (*Annelida, Clittellata*) of the **Nachusa Grasslands** area, Lee and Ogle Counties, Illinois, USA. Final Report for 2016. 20 pp. + appendix.

Wiggins, H., and T. Hodgman. 2016. **Bloomington Water Fund** Business Plan. The Nature Conservancy's NatureVest and Duke University. Final Report. 22 July 2016

Presentations & Posters

*(The Nature Conservancy staff and projects in **bold**)*

Allender, M. 2016. Health Assessment of Ornate Box Turtles at **Nachusa Grasslands**. Presentation at the Second Annual **Nachusa Grasslands** Scientific Research Symposium, Franklin Grove, IL.

Barber, N. A., K. W. McCravy, and K. A, Lamagdeleine-Dent. 2016. Species and functional trait re-assembly of ground beetle communities in restored tallgrass prairie. Presentation at the North American Prairie Conference, Normal, IL.

Bekerman, T., A. Giuo, H.M. Hagy, K. Wolters, D. Jen, and B. O'Neal. 2016. Breeding ecology of marsh birds in a floodplain of the Illinois River. Poster at the National Great Rivers Research and Education Center Symposium, Alton, IL.

Bekerman, T., A. Giuo, H.M. Hagy, K. Wolters, D. Jen, and B. O'Neal. 2016. Breeding ecology of marsh birds in a floodplain of the Illinois River. Presentation at the National Great Rivers Research and Education Center Symposium, Alton, IL.

Bennett, D., A. Johnson, K. Dungey, and M. J. Lemke. 2016. The effect of flooding on water quality in restored and unrestored Illinois River floodplain lakes. Midwest-Great Lakes Society for Ecological Restoration, Chicago, IL.

Bennett, D., A. Johnson, K. Dungey, and M. J. Lemke. 2016. The Impact of flooding on water quality in restored and unrestored Illinois River floodplain lakes. Poster at the **Emiquon** Science Symposium, Lewistown, IL.

Benedict, M. M., and **A. M. Lemke**. 2015. Response of benthic macroinvertebrate communities to large-scale lake restoration. Presented at the 7th Annual Midwest Great Lakes Chapter Meeting of the Society for Ecological Restoration in Glencoe, Illinois.

Blackburn, R. 2016. Bison Diet Preferences and Impacts Using Drones and Stable Isotopes. Presentation at the Second Annual **Nachusa Grasslands** Scientific Research Symposium, Franklin Grove, IL.

Burke, A. and H. Jones. 2016. Small mammal research at **Nachusa Grasslands**. Poster Presentation at the Phi Sigma Biological Science Student Research Symposium, DeKalb, IL.

Burke, A. and H. Jones. 2016. Small mammal research at **Nachusa Grasslands**. Presentation at the Second Annual **Nachusa Grasslands** Scientific Research Symposium, Franklin Grove, IL.

Burke, A. and H. Jones. 2016. Small mammal research at **Nachusa Grasslands**. Presentation at the Friends of **Nachusa Grasslands** Annual Meeting.

Burke, A. and H. Jones. 2016. Small mammal research at **Nachusa Grasslands**. Presentation at the American Mammal Association Conference.

Casper, A. F., et al. 2016. Restoration in Floodplain Rivers: Expectations, Experiences, and Controversies. Dept. of Biology Western Illinois University, Macomb IL.

Casper, A. F., et al. 2016. Expectations & Insights about Large River Floodplain Restorations: Floods, Invasive Species & Stakeholder Tradeoffs. *Invited symposia speaker* at the 146th American Fisheries Society Annual Conference, 'Global Importance and Threats to Floodplain Fisheries: Potential Mitigation to Reconnect Floodplains, Including Synergistic Benefits of Working with Others.' Water Resource Sectors Symposium, Kansas City, MO.

Chantos, K. and W. Swingley. 2016. Impacts of bison reintroduction on soil geochemistry and microbial communities in a tallgrass prairie. Presentation at the Phi Sigma Biological Science Student Research Symposium, DeKalb, IL.

Chantos, K. and W. Swingley. 2016. Impacts of bison reintroduction on soil geochemistry and microbial communities in a tallgrass prairie. Presentation at the Goldschmidt Conference, Yokohama, Japan.

Chantos, K. and W. Swingley. 2016. Impacts of bison reintroduction on soil geochemistry and microbial communities in a tallgrass prairie. Presentation at the Midwest Geobiology Symposium, Cincinnati, OH.

Chantos, K. and W. Swingley. 2016. Impacts of bison reintroduction on soil geochemistry and microbial communities in a tallgrass prairie. Presentation at the Second Annual **Nachusa Grasslands** Scientific Research Symposium, Franklin Grove, IL.

Chantos, K. and W. Swingley. 2016. Reintroduced megafauna impacts on soil microbial communities in tallgrass prairie. Presentation at the Midwest Ecology and Evolution Conference, Miami, OH.

DeBoer J., A. Fritts, M. Fritts, R. Pendleton, L. Solomon, and T. D. VanMiddlesworth. 2016. Life-history expression of three popular sportfish from three distinct habitats in the Illinois River Watershed. Presented at the 2016 Midwest Fish and Wildlife Conference, Grand Rapids, MI.

DeBoer, J. A., A. K. Fritts, M. W. Fritts, R. M. Pendleton, L. E. Solomon, and T. D. VanMiddlesworth. 2016. Life-history expression of three popular sportfish from three distinct habitats in the Illinois River Watershed. Platform. Joint Conference of the Illinois Lakes Management Association and Illinois American Fisheries Society. Springfield, IL.

DeBoer, J. A., A. K. Fritts, M. W. Fritts, R. M. Pendleton, L. E. Solomon, and T. D. VanMiddlesworth. 2016. Life-history expression of three popular sportfish from three distinct habitats in the Illinois River Watershed. Platform. Midwest Fish and Wildlife Conference. Grand Rapids, MI.

Fliginger, J. 2016. Comparing bison and cattle parasites at **Nachusa Grasslands**. Poster Presentation at the 2016 Northern Illinois University Undergraduate Research and Artistry Day.

Fritts, M. W., J. A. DeBoer, A. K. Fritts, R. M. Pendleton, L. E. Solomon, T.D. VanMiddlesworth, and A. F. Casper. 2016. Intersex condition in male Largemouth Bass, Bluegill, and Black Crappie from the Illinois River Waterway. Presented at the 2016 Midwest Fish and Wildlife Conference, Grand Rapids, MI.

Garfinkel, M. and C. Whelan. 2016. Bird provisioned pest removal services on conventional farms: an evaluation of an ecosystem services approach as a tool for prairie bird conservation. Poster presented at Second Annual **Nachusa Grasslands** Scientific Research Symposium, Franklin Grove, IL.

Garfinkel, M., and C. Whelan. 2016. Future directions for bird-provisioned pest control studies in conventional agricultural systems. Oral presentation at North American Ornithological Conference, Washington D.C.

Gilbert, A. D., H. M. Hagy, K. Wolters, D. Jen, and B. O'Neal. 2016. Breeding ecology of marsh birds in a floodplain of the Illinois River. Poster at the **Emiquon** Science Symposium. Lewistown, IL.

Gilbert, A. D., H. M. Hagy, A. P. Yetter, C. N. Jaques. 2016. Detection and disturbance rates of waterfowl during aerial surveys. Poster at the **Emiquon** Science Symposium. Lewistown, IL.

Hagy, H. M., C. S. Hine, T. D. VanMiddlesworth, A. F. Casper, A. P. Yetter, and J. M. Osborn. 2016. The response of waterbirds and vegetation during restoration at **Emiquon Preserve.** Oral Presentation. **Emiquon** Science Symposium, Lewistown, IL. *(Invited)*

Hagy, H. M. 2016. Wetland types and management techniques. Oral presentation at the Wetland Waterfowl Management Workshop hosted by Ducks Unlimited, Jasonville, IN. *(invited)*

Hagy, H. M., M. M. Horath, A. P. Yetter, C. S. Hine, and R. V. Smith. 2016. Evaluating tradeoffs between sanctuary for migrating waterbirds and recreational opportunities in a restored wetland complex. Poster at the **Emiquon** Science Symposium**.** Lewistown, IL.

Hagy, H. M., C. S. Hine, T. D. VanMiddlesworth, A. F. Casper, A. P. Yetter, and J. M. Osborn. 2016. The response of waterbirds and vegetation during restoration at **Emiquon Preserve**. Oral Presentation. **Emiquon** Science Symposium, Lewistown, IL.

Herakovich, H. and H. Jones. 2016. The effects of bison reintroduction on grassland bird nest success in tallgrass prairie. Presentation at the Second Annual **Nachusa Grasslands** Scientific Research Symposium, Franklin Grove, IL.

Herakovich, H. and H. Jones. 2016. The effects of bison reintroduction on grassland bird nest success in tallgrass prairie. Presentation at the Quad City Audubon Monthly Meeting.

Herakovich, H, H. Jones. 2016. The effects of bison reintroduction on grassland bird nest success in tallgrass prairie. Presentation at the 2016 North American Prairie Conference, Normal, IL.

Herakovich, H. and H. Jones. 2016. Restoring major ecosystem drivers in one of the world's most endangered ecosystems: The effects of bison reintroduction, prescribed fire, and restoration age on declining grassland bird populations in tallgrass prairie. Poster Presentation at 2016 Prairie Enthusiasts Conference.

Hine, C. S., H. M. Hagy, A. P. Yetter, M. M. Horath, and J. M. Osborn. 2016. Response of waterbirds and wetland vegetation relative to key ecological attributes at **Emiquon Preserve**, 2007–2015. Poster at the **Emiquon** Science Symposium, Lewiston, IL.

Jones, H. 2016. Bison diet preferences and impacts using drones and stable isotopes. Poster Presentation at the 2016 Second Annual **Nachusa Grasslands** Scientific Research Symposium, Franklin Grove, IL.

Jones, H. and A. Burk. 2016. Small mammal research at **Nachusa Grasslands**. Presentation at the 2016 North American Prairie Conference, Normal, IL.

Kirkham, K. G. 2016. 2018 Farm Bill Member Input Sessions. Presented at the 2016 WILL Ag Farm Assets Conference, Normal, IL.

Kirkham, K. G. 2016. Overview of The Nature Conservancy's BMP Research in the **Mackinaw River Watershed**. Presented at the Illinois State University Department of Agriculture and Department of Geography-Geology Best Management Practices Outreach meeting, Lexington, IL.

Kirkham, K. G. 2016. The Mackinaw River Program: Improving water quality and protecting diversity in a highly agricultural watershed in Illinois. Presented at the Illinois Grand Prairie Master Naturalists meeting, Bloomington, IL.

Kirkham, K. G., A. R. Maybanks, A. M. Lemke, M. Day, D. A. Kovacic, W. P. Wallace, K. L. Bohnhoff, J. R. Kraft, A.T. Noto, and R. M. Twait. 2016. Innovative conservation planning and implementation in tile-drained drinking water supply subwatersheds of the **Mackinaw River**, Illinois. Presented at (a) The Nature Conservancy Central US Division Science and Stewardship Meeting, Austin, TX, and (b) the **Emiquon** Science Symposium, Lewistown, IL.

Kirkham, K. G., A. M. Lemke, A. R. Maybanks, W. L. Perry, J. R. Kraft, M. P. Wallace, D. A. Kovacic, K. L. Bohnhoff, A. T. Noto, R. M. Twait. 2016. Overview of 15 years of best management practice research in the Mackinaw River watershed, Illinois. Presented at the Soil and Water Conservation Society annual meeting, Louisville, KY.

Lemke, A. M. and R. W. Twait. 2016. Green infrastructure for source water protection and biodiversity improvement in Bloomington, Illinois, USA. Presented at The Annual American Water Works Association Conference, Chicago, IL.

Lemke, A. M. 2016. **The Mackinaw River Program**: The Nature Conservancy's approach to improving water quality and protecting diversity in a highly agricultural watershed in Illinois. Presented to Osher Lifelong Learning Institute at Bradley University, Peoria, IL.

Lemke, A. M. 2016. Source Water Protection in the Mackinaw River, Illinois. Presented at (a) 9th Annual Upper Mississippi River Conference: Raising the Grade, Moline, IL, and (b) Coca-Cola Global Water Summit 2016, Chicago, IL.

Lemke, M. J., H. M. Hagy, A. F. Casper and H. Chen. 2016. Floodplain shallow lake and wetland restoration along the mid-reach of the Illinois River. Midwest Society for Ecological Restoration. Accepted.

Lindsay J. M and S. R. Johnson. 2016. *Breakfast of Champions* "Kinetic Characterization of a Novel sPLA2 Enzyme from the Northern Paper Wasp *Polistes fuscatus*"

Luzbetak, D. and N. A. Barber. 2016. The recovery of dung beetles (*Scarabaeidae*) in restored tallgrass prairies with bison. Poster Presentation at the NIU Undergraduate Research and Artistry Day.

Maybanks, A. R. 2016. Investing in water: The Nature Conservancy's **Mackinaw River Program**. Presented at the Illinois State University Human Ecology class, Normal, IL.

Maybanks, A. R. 2016. Cover crops at The Nature Conservancy. Presented at the Coles County SWCD Cover Crop Seminar, Mattoon, IL.

Maybanks, A. R. 2016. Careers in agriculture and conservation. Presented at Peoria Heights High School class, Peoria Heights, IL.

McEuen, A., McCarver, D, Seidel, D. and J. Sherell. 2017. Using Seedling Plugs to Enhance Prairie Species Diversity: Comparing Southern and Northern Species. Stewardship Network Conference. Lansing, MI.

Pendleton, R. M., A. F. Casper, A. K. Fritts, M. W. Fritts, J. A. DeBoer, L. E. Solomon, and T. D. VanMiddlesworth. 2016. The evaluation of a cost-effective, digital approach to estimate fecundity in freshwater fishes. Presented at the 2016 Midwest Fish and Wildlife Conference, Grand Rapids, MI.

Pendleton, R. M., A. F. Casper, A. K. Fritts, M. W. Fritts, J. A. DeBoer, L. E. Solomon, and T. D. VanMiddlesworth. 2016. The evaluation of a cost-effective, digital approach to estimate fecundity in freshwater fishes. Poster at the **Emiquon** Science Symposium. Lewistown, IL.

Seidel, D., J. Sherell, G. Kennedy, A. McEuen. 2016. Can geographic ranges predict seedling success in tallgrass prairie restorations? Poster at the **Emiquon** Science Symposium. Lewistown, IL.

Seidel, D., J Sherell, G. Kennedy and A. McEuen 2016. Can geographic ranges predict seedling success in tallgrass prairie restorations? UIS StARS Symposium, Springfield IL.

Swingley, W. D. 2016. Agricultural Scars and Prairie Restoration. Presentation at the University of Illinois at Chicago, Chicago, IL.

Swingley, W. D. and K. M. Chantos. 2016. The Microbiome of Prairie Restoration. Presentation at Indiana University Purdue University – Fort Wayne, Fort Wayne, IN

Vanderhorst, S. E., H. M. Hagy, C. N. Jacques, and J. W. Simpson. 2016. True metabolizable energy of submersed aquatic vegetation for dabbling ducks. Presentation at the Illinois Chapter of the Wildlife Society 52nd Annual Meeting, Makanda, IL.

Vanderhorst, S. E., H. M. Hagy, J. W. Simpson, and C. N. Jacques. 2016. True metabolizable energy of submerged aquatic vegetation for dabbling ducks. Presentation at Western Illinois University Graduate Symposium, Macomb, IL.

Vanderhorst, S. E., H. M. Hagy, and C. N. Jacques. 2016. True Metabolizable Energy of Submersed Aquatic Vegetation for Dabbling Ducks. Poster at the **Emiquon** Science Symposium. Lewistown, IL.

VanMiddleswoth, M., A. F. Casper, J. A. Deboer, J. M. Levengood. 2016. Rates of Endocrine disruption in two commercial fishes along a downstream gradient in the Illinois River. Poster at the **Emiquon** Science Symposium. Lewistown, IL.

VanMiddlesworth, T. D., J. A. DeBoer, A. K. Fritts, M. W. Fritts, D. M. Kellerhals, R. M. Pendleton, L. E. Solomon, and A. F. Casper. 2016. Estimating population size of select indicator fishes at The Nature Conservancy's **Emiquon Nature Preserve** prior to Illinois River re-connection. Poster at the **Emiquon** Science Symposium. Lewistown, IL.

VanMiddlesworth, T. D., J. A. DeBoer, A. K. Fritts, M. W. Fritts, D. M. Kellerhals, R. M. Pendleton, L. E. Solomon, and A. F. Casper. 2016. Estimating population size of select indicator fishes at The Nature Conservancy's **Emiquon Nature Preserve** prior to Illinois River re-connection. Poster. Mississippi River Research Consortium. La Crosse, WI.

VanMiddlesworth, T. D., J. A. DeBoer, A. K. Fritts, M. W. Fritts, D. M. Kellerhals, R. M. Pendleton, L. E. Solomon, and A. F. Casper. 2016. Estimating population size of select indicator fishes at The Nature Conservancy's **Emiquon Nature Preserve** prior to Illinois River re-connection. Poster. Joint Conference of the Illinois Lakes Management Association and Illinois American Fisheries Society.

Walk, J.W. 2016. Bird Response to Bison Grazing at **Nachusa Grasslands**. Presentation to Lake County Audubon Society, Libertyville, Illinois.

Walk, J.W. 2016. Bird Response to Bison Grazing at **Nachusa Grasslands**. Presentation to Starved Rock Audubon Society, Ottawa, Illinois

Walk, J.W. 2016. Illinois Birds: A Century of Change. Presentation to Peoria Audubon Society, Peoria, Illinois.

Walk, J.W. Coping with a changing climate: challenges and resources for land trusts. Presentation to Prairie State Conservation Coalition, Ottawa, Illinois.

Walk, J.W. 2016. Science at The Nature Conservancy. Presented to Osher Lifelong Learning Institute at Bradley University, Peoria, Illinois.

Walk, J.W. 2016. Prairies, Birds, and Climate Change. Keynote presentation to the 2016 North American Prairie Conference, Normal, Illinois.

Walk, J.W. 2016. Prairies, Birds, and Climate Change. Presentation at Northern Illinois University, Dekalb, Illinois.

Walk, J.W., B. Kleiman, S. Hagen. 2016. The Illinois Fire Needs Assessment. Presentation to Illinois Chapter of The Wildlife Society, Makanda, Illinois.

Ward, R., M. VanMiddlesworth, J. A. DeBoer, R. M. Pendleton. 2016. Common carp age and growth trends. Poster presentation at the **Emiquon** Science Symposium. Lewistown, IL.

Wetzel, M. J., J. W. Reynolds, and M. A. P. Morgan. 2016. Current status of a survey for earthworms at **Nachusa Grasslands** in Illinois. Presentation at the Society for Freshwater Science Annual Meeting.

Wetzel, M. J., J. W. Reynolds, and M. A. P. Morgan. 2016. Current status of a survey for earthworms at **Nachusa Grasslands** in Illinois. Presentation at the 13th International Symposium on Aquatic Oligochaeta. September, 2015.

Wetzel, M. J., J. W. Reynolds, and M. A. P. Morgan. 2016. Current status of a survey for earthworms at **Nachusa Grasslands** in Illinois. Presentation at the Florida Association of Benthologists Annual Meeting. November, 2015.

Interviews & Media Coverage

*(The Nature Conservancy staff and projects in **bold**)*

Constructed wetlands video. Illinois Water Resources Center, University of Illinois Extension, Anjanette Riley, Communication coordinator, August 2016. **Maria Lemke**, David Kovacic (University of Illinois) and Lowell Gentry (University of Illinois) interviewed regarding benefits of constructed wetlands. http://www.iiseagrant.org/newsroom/video-shows-where-natures-kidneys-get-their-name

Wetland Projects Seek to Improve Water Quality. Illinois Farm Bureau Partners magazine, Anna Ziegler, Summer edition 2016. **Krista Kirkham,** Mike Wallace, Rick Twait, and landowner/farmers Mike O'Neil and Tim Kraft interviewed regarding CP-39 constructed wetlands in the **Lake Bloomington** watershed.